THE INFLUENCE ON ARCHITECTURE OF MODERN METHODS OF CONSTRUCTION.

By Henry H. Hill, B.A., R.I.B.A. Essay Medallist 1909.

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CONTEMPORARY criticism, and criticism of the recent past, can never claim exactly to estimate the permanent value of the events, or matters, with which it deals. Rather its function lies in trying to discover the tendencies of things, how far they succeed, or in what manner they fail, in reaching the ideal of their time. And in the present case, although to classify the many differences of expression in modern architecture would not be a difficult matter, for it might fairly be reviewed in kaleidoscopic fashion simply by taking a ride on the top of an omnibus from the Bank to the Marble Arch; yet to observe more than a multitude of buildings in a multitude of styles, to do more than arbitrarily assess their present artistic value, to perceive some common idea uniting them all beneath their differences, would require an unusual power of critical insight.

Like everything else that is modern, architecture has become a very complex affair, and is strikingly different, both in practice and principle, from what it was little more than a hundred years ago. That tidal wave of progress for which the nineteenth century is so remarkable, naturally was not without immediate effect upon the building arts. New conditions of planning arose necessitating emancipation from the limited notions of architectural composition then prevailing, and there was a demand for buildings to serve, like railway stations, new purposes hitherto undreamed of. Two important elements in the general movement, also, the romantic revival in literature, and the advancing science of engineering, had each a special influence. The former was mirrored in architecture in the Gothic revival, and in a measure, too, in the Greek revival; while to the latter was due the invention of the two new structural factors—iron and concrete. Altogether it may be taken that three influences came into play—utilitarian, æsthetic, and structural, as they may conveniently be termed. They, of course, overlap considerably, and it is often impossible to distinguish where one begins and another ends; yet, in the main, it is not difficult to observe the workings of the first two. It is easy to see, for instance, where purely modern requirements, such as those of the Board school, or the hospital, have brought about the evolution of a new type of building, with a distinctive expression of its own. A knowledge of the history of the art, too, makes it possible nearly always to recognise the source, or sources, from which the idea for the design of a building has been derived. But with the structural influences the case is different, since their operation is not so evident externally. The term is a wide one; for it may be taken to include, not only the employment of iron and concrete in construction, but also that of terra-cotta for facing, and of a multitude of patent methods and materials of all kinds; while even the organisation and conduct of building operations may come, though less directly, within its scope.

In the present essay, however, it is proposed only to investigate those methods of construction that directly influence architectural expression. And therefore devices such as "Mack" partitions, which are intended chiefly to meet the exigencies of building economics, will not here receive consideration. Even so important a custom as the use of terra-cotta must, since its end is in the main decorative rather than constructional, give place to those other innovations that more fundamentally affect structural principles and compel the serious attention of æsthetics—that is to say, to the employment of iron and concrete in building.

In this view of the subject there is little occasion to consider its history; how first of all cast-iron was used, then wrought-iron came in, after that steel, and now concrete and steel are often so intimately blended as to become one single material, ferro-concrete, or concrete-steel. Neither is it necessary to discuss the various systems in which these two materials are combined at the present time to form piers, girders, floors, and roofs; for the main principle, that of post and lintel, is always the same. Extremely slight and widely-spaced columns of iron, or ferro-concrete, can carry beams of similar composition supporting enormous loads. By these means feats of construction have been accomplished, beside which, regarded solely as such, the achievements of the French in their cathedrals of the thirteenth century are but clumsy makeshifts, and the possibilities of vaulting in concrete over great spaces are greater to-day than they were even in the time of the Roman Empire. How architecture has availed itself of these new forces, and in what added beauty it pays tribute to its new source of strength, are the questions that now require to be considered.

In Liverpool there is a great cathedral in course of erection, where the whole superstructure consists of brick and stone, built up in the traditional way, and no iron is used at all. While the erection of the *Morning Post* Offices was proceeding, one could watch a wonderful framework of steel gradually becoming woven together. Now, all this is hidden behind a beautiful granite building, which, to the casual eye, betokens in no way the facts of its construction. Facing down High Holborn, and standing out at right angles to the Holborn Empire, is a tailor's shop, and above it a grandiose edifice, which, to all outward appearance, is miraculously supported upon nothing. Here there can be no doubt but that modern methods have been employed; yet the architectural part of the design pays no heed to them, and seems to be all unconscious of the aching void beneath. Finally, there is Messrs. Mappin & Webb's new shop in Oxford Street, where architecture has departed altogether from its customary ways to pay, as it were, an extravagant compliment to its servant—steel.

These four examples, selected at random, present the anomaly of the case. There are many buildings, some of them of considerable importance, in which iron and concrete find no employment. There are others in which their use has occasioned no change in outward expression. Again, there are some in which the new construction is only too obvious, despite the strivings of their designers to hide it. And lastly, it occasionally happens that the structural lines are so clothed that they become the leading motive of the design.

To perceive the influence of the new construction it is by no means necessary, especially in a work aiming at any of the subtler architectonic qualities, actually to see either of its components. Both are without inherent beauty, and their æsthetic value lies only in what they can achieve. They have become the skeleton of architecture, and need to be clothed with more beautiful materials, if the power and beauty of their achievement are advantageously to be displayed. But the rightful use of iron in construction has always been a subject of hot contention. At one time the exposed column was anathema to the artistic, at another the concealed girder. In the days when cast-iron was the vogue, it was the custom to leave it uncovered, and to decorate it with architectural details borrowed wholesale from the various styles. Such a practice, it need hardly be said, betrayed a very primitive notion of art, and was quite incom-

patible with the highly developed artistic spirit of the nineteenth century in other directions. In this way iron gained for itself a bad name, and one which did not disappear when experience, and a variety of practical reasons, proved the advisability of encasing it, whenever possible. The purist school then, ignorant of the practical politics, clamoured that to cover up any construction, no matter how unsightly, was a sham and a lie. But this objection is not so loudly raised now as it was a few years ago. Perhaps it is beginning to be realised that there is a difference between the covering of construction and the hiding of it. An attached column of stone or marble, placed in front of an iron one, appears to do work that in reality it does not perform. Here the visible column, æsthetically the symbol for support, gives that idea exactly where the building is, in fact, supported ; and therefore the proceeding may be justified. But when, on the other hand, the stone column stands in such a position that it does not, nor could not, bear the weight it appears to carry, while the necessary support is placed elsewhere, and perhaps receives no architectural acknowledgment, then there is æsthetic falsity, and no one can cavil at the purists for condemning it.

Modern methods of construction, whether for artistic reasons or for reasons of economy, or perhaps because of a spirit of conservatism on the part of the majority of architects, rarely find employment unless some practical consideration makes their use expedient. They do not appear in buildings the conditions of whose erection remain the same as they were a century ago, and rarely to an extent sufficient to influence the external design in edifices where architectural magnificence is one of the first essentials. Thus in churches, houses, and nearly all country work, the steel stanchion and concrete floor have no place ; while in town halls, public buildings, and the offices of wealthy companies, though concrete floors are used, these of themselves have but little influence on outward design. On the other hand, in the various types of building existing for business purposes, where modern conditions are entirely different from those of the past, the full use of iron and concrete construction is necessitated by the following requirements :— (1) Abundance of light, (2) the maximum of unencumbered floor space, (3) great height, and (4) fire-resisting construction.

It will be observed that the necessity for light has been placed first, for, since that deals with the proportion of solids to voids, it is the prime factor in regulating the outward appearance of buildings, whose general form is predetermined, as is the case with commercial buildings, by their situation in a street. The great size, too, and depth of many apartments used for business purposes aggravate the need for big window areas, until they become so great, that in many large buildings—shops especially, where windows are required for display as well as light—walls can hardly be said to exist at all. They are, at all events, reduced to a minimum, and piers, existing solely for the support of the floors and roof, take their place.

The results of this kind of construction are most readily seen in factories and warehouses, where good light is required. The modern warehouse is no longer a great cliff of walling, pierced at intervals by rows of windows, but has become more often a criss-cross of vertical and horizontal lines, piers and curtain walls to floors, with sometimes the emphasis on the one, by making the former project, sometimes on the other, by keeping both in the same plane, and making the latter the wider of the two. This bold and direct expression of construction, however, often can only be attained by sacrificing the usual forms and niceties of architecture, and indeed a great many warehouses have no pretensions in this direction at all.

In hotels, flats, offices, and other town buildings, where appearance is deemed important, and the demand for great windows is not so exacting, a more liberal expanse of wall space, and one adorned with architectural features, may render the facts of the construction not so obvious as they are in factories and warehouses. Here it may sometimes be difficult to tell at a glance whether the fire-proof floors are carried on girders and stanchions, or whether they rest upon

the walls themselves. It depends, as a rule, upon the height of the building, upon the weight to be carried, and upon the demand for floor area. In a lofty building, for instance, on a confined and valuable site, where every square inch of ground has to be occupied profitably, iron stanchions must be used in order that the walls may be kept quite thin; while in a small building, where the weight is moderate, they are unnecessary, walls of the thickness imposed by the building regulations being sufficient, generally speaking, to bear the load. Although the design of the *Morning Post* Offices has in no way attempted to express the skeleton that gives rigidity to its form, a close observer can hardly help sensibility to the thinness of its walls, even without specially noticing their dimensions. In fact, it is almost impossible to embody iron, or reinforced concrete, in the walls of a building without some evidence of its use appearing externally. Either their abnormal thinness makes the work look a mere shell; or solidity is concentrated in the piers or columns, which, with or without the assistance of stanchions, carry the girders, while the spaces between are so treated that emphasis comes all on the voids, the solids appearing to act only as their decorative framework. Of the latter type there are now a great many instances, and Messrs. Dewar's building in the Haymarket may be mentioned as a recent and, on the whole, a successful addition to them. This kind of design, indeed, is peculiarly characteristic of the present time, and its development is of especial interest, seeing that it is the direct outcome of the new construction, and has revived a principle—that of the pier, as opposed to the wall—dead since the end of the Gothic period, in combination with a manner of architecture based chiefly upon the forms of the later Renaissance.

The constructive versatility of iron and concrete is, in some senses, its greatest misfortune. As the agent of what may be termed crude utility, modern construction, in the easy accomplishment of its end, often ignores and degrades architecture, reducing it to the ignoble function of decorating merely the portions of a building not required for any directly profitable purpose. The conditions of modern shopkeeping demand two incompatible things: the one, an imposing and attractive edifice, that may readily be distinguished from its neighbours, and so advertise the business carried on within; and the other, the absolute maximum of window space on the ground floor, and sometimes on the first floor as well. The latter is generally the more urgent requirement, and thanks to the aid of iron girders and columns, the majority of shops one sees nowadays are lofty and grandiose structures pendant upon shining acres of plate-glass. Such erections can never be successful pieces of architecture. Yet their failure must not be attributed to the properties of their construction. Rather it is due to the utilitarian demands, that, pushed to their utmost, are subversive of the most fundamental notion of architecture. The primary essential of building is stability, and it follows, surely, that the appearance of it is what one may first expect in architecture. The shop problem seems, indeed, to be an architectural enigma; and, though efforts are perpetually being made to solve it, no satisfactory type of general treatment, applicable on a large scale, has yet been found.

The commonest way of dealing with it, perhaps, is to give it up as hopeless, and try to find solace, as one can conceive the architect of the tailor's shop by the Holborn Empire to have done, in imagining the ground story. Another common, but less negative, attempt is seen in the placing of granite pilasters, or stone piers, in front of the iron supports, and making them as wide as circumstances will allow. But this is not a satisfactory system on a large scale; for, unless the piers be sufficient to satisfy the eye, they only aggravate the sense of insecurity instead of reducing it. No matter how massive the pier, too, it cannot, as is seen in Messrs. Waring & Gillow's, otherwise one of the finest of modern shops, compensate for an exceptionally long and heavily loaded lintel.

Occasionally it happens that, instead of piers, attached columns are used in front of the stanchions; and when these come sufficiently close together, the result may be quite satisfactory.

The column is the natural and traditional support of the beam. So it is that, area for area, a column looks stronger under an entablature than does a built-up pier, which belongs with more propriety to the arch. In this respect it is interesting to observe a new building that has recently been erected at the corner of Oxford Street and Great Chapel Street, and is now about to be occupied by the Hackney Furnishing Company. Here the ground floor is, as usual, a complete void, except for a few Doric columns attached in front of the stanchions. These, of themselves, are obviously insufficient to bear the weight of the building; yet it does not appear to lack support, except in the Oxford Street front (the narrower one), which fails because the columns are set apart considerably more than their own height, and the entablature seems to overpower them. Now the cause of success here appears to be two-fold: in the first place, because of the idea of support that is inseparable from a column, when at all rightly used; and, in the second place, because modern sensibilities, growing accustomed to the use of iron, are learning unconsciously to make allowances for it, and so the mind can conceive a notion of strength from a much less given mass than was necessary for this purpose in the past.

The method of arching over the ground floor void only succeeds when it is possible to use sufficiently large piers for abutment. And when this is the case, as in the arcade under the Piccadilly Hotel, the arches are, or at all events appear to be, strong enough to do their work, and so all evidence of the presence of ironwork behind disappears. In small shops, when a single arch spans the whole front, appearing to depend upon the neighbouring houses for support, the result is nearly always unsatisfactory, because the construction is untrue. The weakness of the arch at once arrests the eye, while the very nature of its form hinders the mind from realising the inevitable girder in the wall above.

The modern type of design, of which Messrs. Dewar's has been cited as an example, is sometimes applied to shops, with the intention that the wide voids will cause the upper part of the building to look light. And the idea is a good one, so far as it can be realised. But the requirements of the shopkeeper nearly always make it impossible to carry the piers up strongly from the ground; and when these, starting in mere coverings to the stanchions, become considerably increased at the first-floor level, they produce a far greater sense of crushing than would be caused by a plain and continuous wall. Messrs. Selfridge's is a new attempt in this direction in England, but, as it is still incomplete, one cannot yet judge of its general effect. It is, however, a steel-frame building of the most advanced type, whose uprights are expressed by a great colonnade (the largest in London, it is said) starting from the first-floor level, while the spaces between are left void, being filled in only by a decorative framework of metal, enclosing the windows, and screening the ends of the floors. Success or failure here will depend upon the treatment of the ground story; for, unless the supports under the great columns look strong enough to carry them, the eye may be more impressed by their ponderousness than by the lightness of the spaces between.*

One more shop must be mentioned in this connection, for it stands at present the *ne plus ultra* of light construction. The whole architectural endeavour of Messrs. Mappin & Webb's is to frame voids. It might be said, indeed, that it is not a building at all, but an erection — a decoration of architectural motives applied to a steel skeleton. Yet the result, in many ways, justifies the means; for, in spite of the too great slenderness of the columns that run through the ground story, the building, if that term be allowed, does appear somehow to "hold up." One may, or may not, like this very original fantasia upon Classic motives, so

* Now that this building is completed, it cannot be said that the pilasters of the ground story are wholly satisfactory. Their returns are cut off by the glass in a mean fashion not worthy of so important a building. Still they are sufficiently broad to cause the eye to infer the presence of piers behind them substantial enough to carry the great columns above. And for this one must at least be thankful. The work presents a number of other points of interest; but, of course, any general criticism of its architecture would be beyond the province of this essay.

totally regardless of Classic form; but here, at all events, is a work of some homogeneity. Here it is a relief not to witness that perpetual wearisome conflict between art and utility that has almost accomplished the divorce of architecture from construction—a calamity that would have a damaging effect on all the arts.

Shop architecture has been reviewed thus rapidly, because in it this struggle is seen in its most acute stage. The cry of the shopkeeper is all for large voids. By the modern means of steel and ferro-concrete they can be provided. But to make them beautiful and positive parts of buildings is a problem for architecture yet unsolved. To make them beautiful, however, is not necessarily to make them magnificent. And in this regard a question arises as to whether modern commercial work has not, on the one hand, often attempted a wrong standard of attainment, and, on the other, is not too often condemned for the absence of qualities it should never possess. To take some famous palace, or some historic building admired for its architecture, and adapt it, no matter how freely, to the present-day utilitarian and structural needs of a shop, or an hotel, is somewhat meretricious art, and tends to set up a false standard of comparison. Of course commercial buildings ought not to be without beauty, since the majority of mankind spends the greater part of its days amongst them; but it does not seem reasonable to expect to find the grandeur, the power, and the eternity of the fine art of architecture in works of this nature. The prime function of a shop, or of a block of offices, or of a warehouse, is utility. They are there for the practical purpose of money-getting, and, though this is by no means incompatible with higher ideas, architecture can no more express the latter, when in the service of the former, than an architect can write the beautiful thoughts of a Ruskin in the pages of a building specification. All that can be asked of commercial architecture is fitness—fitness both of decoration and construction; for this, though not itself one of the higher forms of beauty, at least makes for dignity and sobriety, qualities in art that are always invaluable.

It would be impossible at the present time to summarise the definite changes that the influence of modern construction has brought about in the ordering and disposing of architecture, for the great transitional period, that began nearly a century ago, is not yet over, and cannot yet be viewed in true perspective. Changes are still taking place, both in the idea of architectural beauty and in the means of its realisation. These do not develop in mutual conjunction, but, as in the other great transition from Romanesque to Gothic, individually and distinctly. The first experiments in Gothic carving were tried upon round-arched architecture; and in the early attempts at using the pointed arch the innovators were quite content to employ the older mouldings and details. In much the same way to-day there are the "artistic" architects, who, concerning themselves chiefly in the pursuit of beauty, prefer to use the older manner of building, because they are sure of their ability to handle it well; and there are the business architects, who, in the endeavour to satisfy urgent practical needs, are compelled to throw the whole of their abilities on the side of constructional development, and take the decorative part of their work second-hand. In this manner the æsthetic idea and the constructive type suitable to the modern world are in course of formation. After a few more years' growth apart one may hope to see their full development crystallised in their reunion, and expressed in a new style, that should be as great in its way as that of any similar period of concentrated effort.

That the new architecture will be one of slender piers and great vaults, enclosing enormous spaces, there is already some evidence; but whether its artistic inspiration will come from the great vaults of the Romans, or the Byzantines, or from the elegant and slender piers of the Gothic cathedrals, or from some happy combination of the three, one cannot as yet accurately predict. There are, however, some signs pointing in the direction of Rome. Modern taste

undoubtedly leans towards Classic architecture. Modern social conditions are, in many respects, not dissimilar to those that prevailed in the Rome of the Empire. And, perhaps of more import than these, there are already in America buildings—notably two great railway stations, at New York and Washington respectively—where the great halls of the Roman baths have supplied a grand idea that has been realised by the aid of iron and concrete construction. The classic orders have a phœnix-like habit of returning to life, renewed in elegance, when almost forgotten in a desert of dulness, or flamboyance. They have become adapted to widely differing conditions again and again, and there is no reason to fear that they will hinder future progress, provided always they escape the meshes of pedantry. For a variety of reasons, structural ones principally, a great classic cathedral, built, say, a hundred years hence, should be as different from St. Paul's, now some two hundred years old, as that differed from the Pantheon that was standing in Rome fifteen hundred years before. And if the vitality of the elements of classic architecture was as great, if not greater in the days of Sir Christopher Wren than it was in the time of the Emperor Hadrian, there is little fear that modern iron and concrete architecture, even though it may not elect directly to make use of them, will sound their death knell.—Let those who shudder at the modern shop console themselves with this!

NOTES ON ARCHITECTURAL TRAINING.*

By Warren P. Laird,
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THE architectural profession in this country differs from others, notably those of law and medicine, in the degree to which the school has been essential to the whole fabric. So many generations have passed since the day of the self-constituted healer that we forget that the medical school was not always the only channel to legitimate practice, while even the lawyer now finds a systematic course of instruction virtually necessary to his preparation for practice.

But these callings have long been recognised as professions, whereas architecture has only within recent years been accorded that rank. Probably the span of a single generation will cover the time since even the more intelligent class of people regarded the architect as no more than a glorified artisan; but within that period there has taken place a development which is probably not rivalled in the history of any art or profession revived from a one-time greatness. An interesting and, I believe, significant fact in this connection is that the architectural school was born and has enjoyed its lusty growth within this same period. Undoubtedly each has stimulated and reacted upon the other, and it is unquestionable that the increasing strength and multiplication of the schools is due to the same impulse which underlies our marvellous professional advancement. It would be difficult, were it not unnecessary, to determine the debt which each owes to the other. But it is at least evident that neither the profession nor the schools have yet arrived at any definite acceptance of a controlling policy, either for education on the one hand or of ideals and methods of practice on the other. It is therefore of less profit to consider what the relations have been between the school and the architect than to discuss what they should be, and to look forward to the time when each will be working in intelligent accord with the other.

What then should be the relation between the architect and the school? What should constitute the training of the architect? For this is the one concern of the school. To prepare the ground for an answer, we may state at the outset the accepted fact that the office, no less than the school, contributes to that training, each providing a part which the other either cannot give at all or give so well. The distinction between these very dissimilar parts is best understood when we contemplate the nature of this most exacting profession.

In ancient days the functions of the architect were relatively simple; indeed he often found it possible to be also a painter or sculptor, a poet or engineer—often several of these, and usually a scholar. But to-day building has become a process of extraordinary range and complexity. The purposes for which buildings are required are a hundredfold more numerous, and the materials used in their construction, both in kind and quantity, are vastly more abundant. Appliances and methods have added enormously to the facility with which results may be obtained, and the whole atmosphere in which the architect now works has as small

* Read before the Philadelphia Chapter of the American Institute of Architects, March 1909.

resemblance to that of his ancient precursor as has our industrial age to that of the Revival of Learning. The difference is most sharply outlined when we realise that the architect's obligations to art have not, and never can be, lessened, while, on the other hand, he must be infinitely more a man of science and of affairs. His daily routine may involve any point in the range from pure art to applied science. He must have at once a mastery of design and a working knowledge of construction. He requires to occupy with sympathetic understanding the view-point of both mural painter and ventilating engineer; he must realise the nice adjustment between cost and earning capacity in his office building and between symbolism and ritual in his place of worship; he should know with equal certainty the exact point which requires, in a façade, the accent of sculpture and, in a foundation, special precaution against danger of settlement. There must be for him no mystery in the mechanism of elevators and dynamos or the structural qualities of a thousand-and-one materials and appliances. The historic past must be to him an open book, and the allied arts a familiar field.

In short, modern science employs an infinitude of agencies of diverse character, all of which must be known to the architect. And this is but secondary to his highest duty, that of so employing these agencies that, while his building shall be sound in construction and adapted to its practical purposes, it must be a thing of beauty, for the architect is, above all, a creative artist—an exemplar in its profoundest sense of that pregnant word "design." Thus, as a designer of buildings, he is responsible not alone for their construction or the methods by which they are brought into existence; for their convenience or adornment or surroundings; but for the completed whole. This is the aim of his labours, and his success is measured by its merit. If it be faulty in construction or inconvenient in arrangement, it is of course imperfect as a work of architecture, whatever its abstract beauty, and its author has, by so much, failed as an architect. But his failure is absolute if his work goes no further than construction and utility, for, though perfect in these respects, if it lacks a just beauty, it is not even a work of architecture and the author has de classed himself into the ranks of the engineer or builder.

Thus the architect does his work under the severest handicap. While his highest function is that of the artist, his most insistent duties are those of the engineer or business administrator. Under these conditions the practice of architecture has become one of the most complex and highly specialised of pursuits, followed under a pressure similar to that of business life, rather than in the atmosphere so necessary to artists in other fields.

Thus it comes that the office is no longer a place for student instruction; it affords no time for teaching. That which must be learnt is too diverse and too specialised for any one man to teach; that which must be taught by method rather than acquired by experience demands the service of the trained instructor and of facilities and opportunities not afforded by the office. For this reason the architectural school has come to be an essential element in the upbuilding of the profession.

Now, what must the school provide that this highly organised profession demands in its practitioners yet cannot itself offer? And what can the office best provide toward the architect's training? Unquestionably the school is the place for theory and the office for its applications; the school for imparting information and the office for experience in its use; the school for the arousing and developing of faculties and qualities for whose growth to maturity the office alone provides the proper atmosphere. Architecture, like other great human activities, is only the working out, consciously or unconsciously, of great underlying truths, and the function of the school is to inculcate these truths and demonstrate them so clearly that they may provide the prospective architect with the foundation for his future career; may give him a comprehensive knowledge and insight into reasons, a body of conviction, an aroused sense of the beautiful, a stimulated imagination. Together with this there must be such attendant discipline as will serve both to demonstrate these truths and to develop his capacity to understand and use them. Thus equipped, the student's powers should steadily develop when brought into contact with the practical realities of office work.

Therefore the training of the school should be made complementary to that of the office, so that one shall fit into the other. It would be less difficult to provide training which would more or less duplicate that of the office instead of supplementing it. But if the purpose of the school were exclusively to fit its students to be of instant use in the office—to be capable only as draughtsmen, then the school has no reason for existence, for each office could serve itself better by doing its own training. On the contrary, the highest debt which the school owes to the student is to train him for his ultimate destiny—that of a practising architect. This can best be done by holding to that ideal which demands that the architect be both a man of education and an artist with sound knowledge of the materials of his art.

First: Education is a fundamental necessity to the architect because the field in which he works is quite as truly intellectual as is that of any other profession. Its operations call for a well-trained mind, no less than for imagination, taste, and judgment; they concern the greatest of the human arts and come into responsible contact with highly organised human activity in many of its phases. Nothing that the architect is called upon to do lies outside of the mental scope of the well-educated man. On the contrary, the more cultured his mind the nobler will be the work of the architect.

Second: That the architect should be an artist requires no assertion and no defence if this work be understood in its true significance. The world does not realise and we too often forget that the archi-

tect stands pre-eminent in the field of art because he is at once the chief artist among craftsmen and the master craftsman among artists. His work has always been distinctive because it is at once the noblest embodiment of pure art and the most essential of the useful arts. His field is unique as the meeting place of human activities elsewhere as far apart as the poles, for in him must be combined the functions of artist and engineer, of dreamer and executive. For this reason the well-organised school devotes its chief attention to training in design, to the development in the student of the creative faculty, of perception and imagination, of the appreciation of beauty in line, colour, and form, and of acquaintance with the masterpieces of architecture. These influences are exerted along many lines of study and constantly attended and reinforced by the discipline of design, through which he is learning the great underlying principles of his art and acquiring facility in their practice.

Attending this work there must be a careful study of the scientific laws underlying sound building construction, as regards both native material and its behaviour under stress. This work is theoretical, but it must be thorough, for upon it rests the intelligent understanding of many things vitally essential to sound building. Also the student must be given such information on practice in building construction as will enable him to take up office work in it, not as a stranger, but with preparedness to put to intelligent use the training he has brought from the school.

This outline of certain technical aspects of the architect's training, although roughly sketched, may suggest the reason for its advancing ideals and the insistence of the schools upon a scheme of teaching which shall make of the architect an educated artist. The architectural schools of the country have arranged and are steadily improving their systems of instruction under a deep sense of responsibility and an open vision toward the future. The relation between the school and the architect is intimate and vital, and the former will grow in usefulness and strength as the latter fosters that relation. One of the most encouraging signs of the times has been the recent activity of the Institute in matters of education. To be fruitful, this must be fully co-operative, and it is of primary importance that the very active and able spirit of inquiry which has thus far characterised the work of the Committee on Education be enlarged into an effective working organisation of which the schools will form an integral part.

PAPERS COLLECTED BY THE R.I.B.A. TOWN-PLANNING COMMITTEE.

No. IV.—THE IMPROVEMENT OF SYDNEY.

The following notes by Mr. John Sulman [*F.*] embodying proposals for Sydney, N.S.W., include several suggestions that will be of interest to students of town planning :—

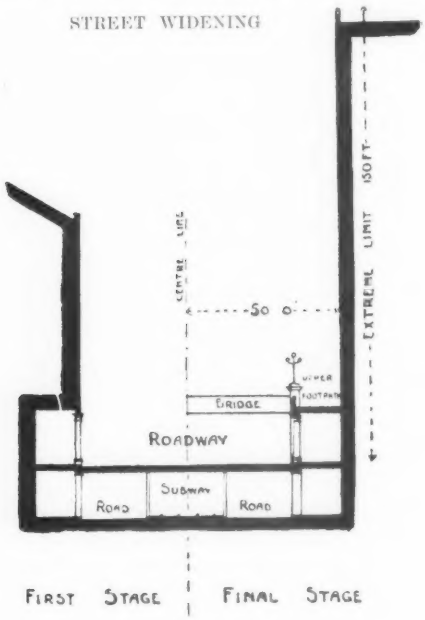
Sydney possesses one characteristic in common with New York, and that is the limitation of the business area. Indeed, in this respect, New York is not so constricted as Sydney, for there is no serious block to its extension northwards into residential quarters, such as the Railway Station, the rise of Surry Hills, and the depression at the head of Darling Harbour, present in our case. Hence as the city grows the business quarter will become more and more congested, and tall, many-storied buildings will become the rule. It is to be hoped that a drastic regulation will be framed and enforced, limiting the height of buildings to, say, 100 feet, or as an extreme limit to 1½ times the width of the streets. We do not want to see American sky-scrapers repeated in our midst, or to reap the harvest of disease they must inevitably produce when the streets are filled with them. But even within the limit suggested the city population will be increased at least five-fold, and tram and road traffic will keep pace therewith. The traffic of the main streets, even as it is, requires careful regulation to make them serve present needs, and in the future we are anticipating they would prove quite inadequate. Their widening, sooner or later, will be absolutely necessary, and the sooner it is effected the less will be the cost. To set back all the frontages, and pull down and re-erect the buildings, would, however, be a task so colossal that it may at once be put aside as impracticable. What we do must be within our means, and should be spread over a number of years, so as to render the cost comparatively light. Otherwise public support would not be forthcoming. I venture to think this may be done.

By a comparatively slight alteration and the loss of ten feet *on the ground floor only*, the whole object aimed at could be attained. Shops of considerable depth could afford twelve or fifteen feet being taken from them without spoiling them altogether. The space would, of course, be a serious loss, and adequate compensation would have to be paid; but it would be far less than if a slice off the whole height of the front were removed. The verandahs and shop fronts would be removed, the latter refixed at the new frontage line, and a new pavement formed at a minimum of expense for structural alterations. The party-walls across the footpaths would, of course, be cut away, and this would render it desirable to insert new columns to carry the superincumbent front wall above. If these were of good and uniform design a dignified effect would be produced. Difficulties would arise in connection with the different heights of ground floors, but they are not insuperable and have been overcome elsewhere,

as those who know Bologna in Italy can bear witness.

AN UPPER FOOTWAY AND BRIDGES.

At a comparatively small cost, therefore, the roadway could be made over sixty feet in width, broad sheltered footpaths secured, with more ample light to the shop fronts behind than they at present enjoy under the limited height of verandahs; but the possibility of obtaining direct light into the shops over the verandah roof, as in some of the newer and more lofty examples, would have to be forgone. That, however, is a very minor matter compared with the great improvement effected. The City Council should also have the power to realign frontages, so that when any owner of a property fronting a street,



widened as suggested, wished to rebuild, he would have to set back the upper stories to the new frontage line, and, of course, be compensated for so doing. As rebuilding would be gradual, the outlay for compensation would be spread over a number of years, and hence not onerous. Probably within fifty years the buildings in the whole of the streets so treated would be re-erected and set back to the new frontage, and if any were left the cost would not be great to bring these into line with the rest. It would also be well to secure, in any case of re-erection, adhesion to a general average level of floor lines, and possibly conformity to some general scheme of architectural treatment. For many years past this has been done in Paris with excellent effect. As a result of rebuilding and setting back the frontage line, the street arcade would be left standing as a permanent architectural feature with a solid flat roof, thus suggesting the possibility of a footway at the first-floor level, and the consequent opportunity of a second range of shop fronts or show rooms or offices, with most of the advantages of the ground floor and some others added, such as better light, more quiet, space, and no necessity to "move on" on the part of those using it. Indeed, if wide enough, the Parisian habit of outside tables to cafés, &c., with plants in tubs, and a roof garden might be indulged in, but with the advantage of being slightly raised above the traffic of the street. Raised footways such as these would mean bridges at the street corners (with staircases of access), which would add to the picturesqueness of the streets, at present somewhat wanting in lines contrasting with the longitudinal and vertical ones now predominant. Such first-floor footways have, I know, been proposed in New York.

STREET CORNERS.

The intersections of busy streets are already the seat of much congestion of traffic and consequent delay, and are only kept in order by the constant attention of the police. With increased traffic, even if streets are widened, they will need some further enlargement. The present crude method is simply to round off a corner. From a practical point of view this leaves much to be desired, for, at the most valuable part of a street frontage, carriage or cab cannot stop to set down or take up passengers, and the delivery of goods is out of the question. Architecturally also, the rounded corner is the most ineffective that could be devised, as a mere glance at those already in existence will convince the most sceptical. A far better form, both practically and artistically, is a hollow forming part of a circle or oval, or, if straight lines are preferred, an octagon or a square. Trams and vehicular traffic would have ample space to negotiate the turn, and still leave space for waiting vehicles at the kerbstone. The enlarged area would also permit of the employment of the up-to-date gyratory regulation of all traffic, by which crossing and stopping the varied streams of vehicles is entirely obviated, and motion would be continuous. These enlarged intersections would also permit of islands in the centre, which could be utilised in a practical fashion for the standards of powerful street-lamps, for sunk sanitary conveniences, or, where subways or railways run underneath, for spacious ventilating openings or stations. When not required for such works of utility, they would afford good opportunities for small street gardens, with possibly one or two seats, and for drinking fountains or *jets d'eau*, when our water supply is ample. If Australia should develop a worthy school of sculpture, even groups of statuary commemorating the events of our history might here find a place for the beautifying of the city, the enjoyment of the people, and the education of the young to a proper pride in our achievements.

SUBWAYS.

The mention of ventilators to subways reminds me that, as an upper-story footpath will be a feature of the future, so a lower-story street will in many cases be equally desirable. In the first place they will no doubt be required for railways, and a quick service of long-distance trams; and in making them there is no reason why cart roads should not be provided as well, so that all goods traffic to the buildings above might be carried on therefrom at all hours of the day. In addition, provision would be made in these underground streets for easy access to the sewers, water and gas pipes, electric light and power, telegraph and telephone cables, &c., and thus rid the streets of the overhead wires which are such an eyesore and even danger, and obviate their frequent tearing up for access to pipes.

AMIENS CATHEDRAL AND MR. BILSON'S REJOINDER.

By Wm. H. Goodyear, M.A.,

Hon. Member Society of Architects, Rome; Hon. Member Edinburgh Architectural Association; Hon. Member Royal Academy of Fine Arts, Milan; Hon. Academician Royal Academy of Venice; Corresponding Member American Institute of Architects.

IT may be a trite observation that the object of controversy should be the discovery of the truth, rather than the humiliation of an opponent. I shall hope, however, to bear this in mind in considering the opening sentences of Mr. Bilson's Rejoinder.* In his original "Criticism"† his general topic was explicitly stated to be the teaching of the Edinburgh Exhibition of Architectural Refinements,‡ and his general thesis was explicitly stated to be that these refinements existed only in my imagination. After my reply appeared in this Journal [9 Nov. 1907], showing, for instance, that about one-third of all the buildings illustrated at Edinburgh were examples of perspective illusions, Mr. Bilson hastens to say: "I have expressed no opinion whatever with regard to perspective illusions."

My only object in calling attention to this palpable inconsistency is to point out that, although Mr. Bilson's wholesale strictures on the teaching of the Edinburgh Exhibition are now revoked, the method of retraction is so indirect and vague as to call for a word of comment on my part. For instance, after it appeared from my Reply that only eighteen out of sixty-one buildings illustrated by the Edinburgh Exhibition represented phenomena like those at Amiens, Mr. Bilson says: "It is scarcely necessary for me to point out that my criticism was not in the least intended to cover everything that Mr. Goodyear has ever written"—thus implying in one and the same sentence that many of the publications cited in my Reply had no reference to the Edinburgh exhibits, and also implying that I have never published anything aside from the ones cited.

Mr. Bilson's suggestion that my published studies have been confined to architectural refinements is parried by the citation of several books from my pen, on the history of art, which appears on the title-page of the Edinburgh Catalogue, and this title-page Mr. Bilson may be presumed to have read. But the more subtle suggestion that my Reply travelled outside of Mr. Bilson's ground of attack calls for prompt denial on my part.* The Edinburgh Exhibition was a condensed choice from Brooklyn Museum exhibits of architectural refinements, including about 278 numbers, and covering 550 linear feet of hanging space with cartoons of survey and survey photographs. Mr. Bilson's original attack made no qualifications and no concessions regarding the architectural refinements specified by the Edinburgh Catalogue. They were all covered by his preface, by his conclusion, and also by the quotation marks of his title, according to his own express statements. Now, however, in rejoinder to my Reply, he says: "It is scarcely necessary for me to point out that my criticism was not in the least intended to cover everything that Mr. Goodyear has ever written."

My answer is that no publications were cited by my Reply which did not directly relate to the Edinburgh exhibits, and that no observation of an architectural refinement was cited in my Reply which was not included in the subject-matter of these exhibits.

Thus the method of Mr. Bilson's retraction shows that his talent for confusing an issue is phenomenal, as further illustrated by his remarks on the entasis in free-standing mediæval columns. When this critic ridiculed my "supposed discoveries" it was not because they were asserted to duplicate observations previously made, but because the observations themselves were asserted to be purely imaginary. Hence I pointed out in my Reply that many of these "supposed discoveries" were parallel with the work of other scholars who were not criticised by Mr. Bilson. I pointed out that the entasis in free-standing mediæval columns was one of those "supposed discoveries" which had subsequently been independently announced by a French scholar of distinction. Mr. Bilson now himself adds the

* Journal R.I.B.A., 7th December 1907.

† *Ibid.*, June 1906.

‡ Opened by the Edinburgh Architectural Association in the Scottish National Portrait Gallery, 6th September 1905, closed 11th November.

* I very much regret that this denial has not been prompt, but the pressure of Museum routine duties has made it wholly impossible for me to make earlier answer.

names of other scholars as having made similar announcements, without reflecting that his title of "Mr. Goodyear's 'Refinements'" ignores every such instance of parallel work.

It is a pleasure to turn from these disagreeable reflections to that phase of the controversy which concerns the widening refinement in the Cathedral of Amiens, and especially so because Mr. Bilson's "willing acceptance" of the measurements published in my Reply* offers a common ground of departure in debate if not of conclusion in results.

The wider acquaintance of experts with the new series of photographic exhibits which furnished not only the measurements for the Amiens nave but also many other new measurements for Amiens, as well as for other French Gothic churches, may effect a startling revolution in our modern studies of Cathedral architecture. Such a revolution can only be inaugurated by controversy, and such a controversy is creditable to the parties engaged in it on either side, provided it be conducted in a spirit of fairness and of good temper. The weighty authority and distinction of some of the experts who have discredited the existence of a mediæval widening refinement is notorious.† Their opposition is, in my opinion, a tribute to the novelty and revolutionary significance of the discovery.

It has been, however, my fortune to procure recently such remarkable evidence for the wide diffusion of this refinement, that not a single expert who has examined the original exhibits has so far questioned their importance. Some of these experts are in Paris, some are in London, some are in the United States, and some are, or have been, officially in charge of debated buildings. I have already mentioned in my previous Reply the favourable opinions of the *Inspecteurs des Travaux* at Amiens ‡ and Rheims, and of the architect recently in charge of St. Loup at Chalons. Were a less serious and less revolutionary series of observations in question the verdict of these architects would alone be sufficient to settle the controversy. M. Margotin's certificate for Rheims merits Mr. Bilson's serious consideration, whereas he has not even given it a passing notice. The new evidence has also already evoked corroborative observations. Professor Reginald Blomfield allows me to mention St. Pierre at Saumur as offering, in his opinion, an instance of constructive widening, and he was led to this observation by an inspection of the photographs when shown in London.* Mr. G. A. T. Middleton's publication of St. Mary's at Dover † was first prompted by his inspection of the new exhibits. M. L. Cloquet, Professor of Architecture in the University of Ghent, and Editor of the *Revue de l'Art Chrétien*, publishes the church at Mouzon (Ardennes) as an instance of constructive widening, and was thereto prompted by the new evidence from Rheims.‡

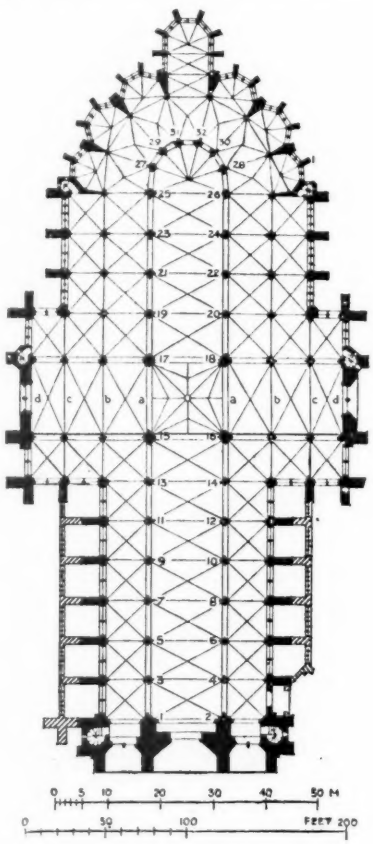


FIG. 1.—PLAN OF AMIENS CATHEDRAL, WITH M. DURAND'S NUMBERING OF THE PIERS.

* Page 85 of his Rejoinder: "Mr. Goodyear's latest observations, which I willingly accept as correct." This is a much valued tribute to the new photographic enlargements from which the accepted measurements were obtained, and especially so, because Mr. Bilson has not examined the original exhibits.

† The term "widening refinement" is used in these prefatory remarks because it includes under one term the instances of widening in straight lines from the pavement up, the instances of widening in straight lines which begin to diverge at the capitals of the piers, and the instances which widen in vertical curves.

‡ Although Mr. Bilson has called in question (page 85 of the Rejoinder) my account of M. Favry's opinion, I shall refuse to credit his suggestion that my account is incorrect. M. Favry spent an hour and a half in examining the new Amiens enlargements. His verdict as to constructive intention in the Amiens widening was specific, unqualified, and highly enthusiastic throughout that interview. This opinion was not drawn out by questions, or elicited as the result of debate. It was freely, spontaneously, and enthusiastically offered.

* Personal letter of 19th January 1908, giving kind permission to publish.

† JOURNAL R.I.B.A., 25th January 1908.

‡ *Revue de l'Art Chrétien*, July 1908, page 225, under "Raffinements architecturaux." Mr. Arthur Hill, F.R.I.B.A., of Cork, had previously published St. John's at Chester as having the constructive widening (*Architect*, Oct. 21, 1904).

I.

Since my measurements for the Amiens nave have been accepted by Mr. Bilson, it is necessary to rehearse them, as published in my first Reply, in order that our present points of agreement and of disagreement may be made to appear. *The explanatory footnotes*, and some other explanations, are also necessarily reprinted, including the preliminary explanation which precedes the table and which follows here:—

This table of measurements for the vertical divergences of the nave and crossing piers is supported by thirty-eight exhibits. In my own numbering of piers I have continued the methods used in my photographic notes, but the numbers of the Durand plan are also supplied, as found in fig. 1. My own numbering enumerates the piers in order from the crossing, not included, as far as the organ gallery, and the tower piers at the entrance, which are also not included, as having no divergence.

RECESSIONS IN THE PIERS OF THE AMIENS NAVE AND CROSSING (IN INCHES).

All recessions, except at the crossing, are in straight lines, and all begin at the capitals, or, in the case of the crossing piers, at the corresponding height.

NORTH.	SOUTH.
East Crossing (17).* Recession, 5; bulge, $1\frac{1}{4}$.†	*East Crossing* (18). Recession, 5; bulge, 3.
West Crossing (15). Recession, 5; bulge, less than 1 inch.	*West Crossing* (16). Recession, 5; bulge doubtful, if any.‡
First Pier (13). Shaft recession, 7; pier perpendicular.	*First Pier* (14). Shaft recession, 5; pier perpendicular.
Second Pier (11). Shaft recession, $8\frac{1}{2}$; pier perpendicular.	*Second Pier* (12). Shaft recession, $6\frac{1}{4}$; pier perpendicular.
Third Pier (9). Shaft recession, $8\frac{7}{8}$–8; pier perpendicular.	*Third Pier* (10). Shaft recession, 7–6; pier leans in, $1\frac{3}{4}$.
Fourth Pier (7). Shaft recession, $9\frac{1}{2}$–9; pier perpendicular.	*Fourth Pier* (8). Shaft recession, $5\frac{3}{4}$–$6\frac{1}{2}$; pier leans in, 1.
Fifth Pier (5). Shaft recession, 12–$11\frac{1}{2}$; pier perpendicular.	*Fifth Pier* (6). Shaft recession, $7\frac{1}{2}$–$6\frac{1}{2}$; pier leans in, $1\frac{1}{3}$.
Sixth Pier (3). Shaft recession, $7\frac{1}{2}$; pier perpendicular.	*Sixth Pier* (4). Shaft recession, $6\frac{1}{2}$; pier leans in, $1\frac{1}{4}$.

Double estimates, offering slight variations, are given for the third, fourth, and fifth piers on each side (Durand plan 9, 10; 7, 8; 5, 6). The right-hand measurements in these cases are from photographic surveys, with plumb-lines reaching, in the photograph, from the base to the capital of the shaft at the vaulting, and with a surveyor's disc on the plane of the given pier at its exact centre. The left-hand measurements for the same piers are figured on a wholly different method, which was also applied to all the piers for which single measurements are quoted, except the crossing piers—*i.e.* by combining the measurement furnished by a specially enlarged photographic detail of a plumb with disc measurement from the triforium string to the capital of the pier (where the outward slant begins) with another estimate for the triforium and the clerestory based on actual plumbs inside the triforium.

* These numbers relate to M. Durand's plan, as reproduced in fig. 1.

† The recessions are figured without including the bulges; in other words, they are figured from the base to the capital at the vaulting ribs. This method differs from that of the Cathedral office drawings. On that method the recession would be $6\frac{1}{4}$ inches for the north-east crossing pier and 8 inches for the south-east crossing pier.

‡ The Cathedral office drawing gives 0·015 m. bulge, or less than $\frac{5}{8}$ inch. If a bulge exists, it is certainly not more. My own observation shows a slight builder's error in some of the masonry courses rather than a bulge. The photographic detail enlargement will enable each student who examines it to form his own conclusions. M. Choisy's impression of this enlargement coincides with my own.

It appears from the reprinted table and footnotes that Mr. Bilson and I are agreed in estimating the recessions of the crossing piers at 5 inches for each pier, excluding the bulges and estimating the recessions from base to capital. In view of his "willing acceptance" of these recent observations it is somewhat ungracious of Mr. Bilson, and if not ungracious it certainly does not square with the facts, to assert that my Reply does not treat the bulges of the crossing piers as accidental. Half a column of the Rejoinder (pp. 86, 87) is based on this very mistaken assumption, and its analysis of my argument for Amiens starts from this point. It is, however, expressly stated in the republished footnote that "the recessions are figured without including the bulges."

This leads to my first point in reply to the Rejoinder, and relating to its fig. 8, viz. the inquiry what has the fissure, shown also by fig. 2 of this Paper and related by Mr. Bilson to a bulge below the triforium, to do with a widening above the arcade capitals, *provided the bulge be not figured in the widening estimate?* Fig. 3 shows, for instance, for the south-west crossing pier that the widening begins below the triforium, at the height of the arcade capitals, and wholly independent of bulge, which is figured by the Cathedral office drawing at the level of the arcade capitals, and as being there only $\frac{5}{8}$ of an inch (0·015 m.), while my recent observations, now accepted by Mr. Bilson, indicate that this bulge does not exist at all.*

Much as has been said by Mr. Bilson about the iron cable, and Pierre Tarisel, and the fissures and cracks in the transepts, it is all dust thrown in the eyes of the public; for what is the upshot of all this output of illustration, of reiterated argument, and elaborate citation about the buckling of the crossing piers, which consumes two entire pages of Mr. Bilson's original criticism, which he says I have made no attempt to answer, and which he now supplements by the first illustration of his Rejoinder, with half a column of related argument. If the worst face be put on the matter, there is only $\frac{5}{8}$ of an inch buckling at the south-west crossing pier, and my own observation calls in question the existence of any bulge whatever in that pier. This observation is based on a special series of detailed enlargements (from pavement to triforium), made for the given purpose, from which

* See footnote to the measure for recession of the south-west crossing pier, as just requoted in this Paper.

the bulges are measured, as shown by the table. It must be that Mr. Bilson "willingly" accepts this recent observation, for it is explicitly included with my measurements for the nave. I do not even insist on this acceptance; what is the use of quarrelling about $\frac{3}{8}$ of an inch? As for the south-east crossing pier, it is an absurd phase of Mr. Bilson's side of the controversy that he has related the fissure published in his Rejoinder to a buckling which does not exist at all, if we are to credit the drawing which he published in his Criticism.* Another absurdity is that the Rejoinder fig. 8 illustrates that side of the transept which shows the maximum fissure and the maximum bulge, whereas the most elementary and obvious rules of fairness demand that we consider the crossing pier and the corresponding side of the transept *where the buckling has been least.*

For if the accidental buckling below has anything to do with the recession above, then we naturally look to the pier where the buckling has been least, in order to inquire how much the original recession above has been increased by buckling below; and when we examine the south-west pier we find that the buckling has been nothing at all, or only $\frac{3}{8}$ of an inch, according to Mr. Bilson's own original contention. On the other hand, if the buckling below has nothing to do with the recession above, what is the use of talking about it? It was not included in the accepted estimates for recession, and Mr. Bilson, who relied on the office drawings, did not know that there was any northward buckling in the south-east pier when he published his Criticism. It was I who first drew attention to it in my Reply.

Thus, I now quote two illustrations, showing cable plumb-lines—one for the south-east crossing pier [fig. 2] and one for the south-west crossing pier [fig. 3]. Fig. 2, of the south-east crossing pier, may be compared with the Rejoinder fig. 8, as showing how the careless levelling or incorrect trim of Mr. Bilson's photograph has entirely obliterated the recession of the south-east pier, the pier being made to appear perpendicular, while the inclinations of the choir piers of the north side are exaggerated and distorted.

Fig. 3, now twice quoted, shows the south-west crossing pier, with cable plumb-line, and enables me to appeal to obvious fairness and to obvious common sense. If fissures are to be quoted as signs of movement in a church, the smallest fissure and the least movement (relating to one and the same cause) enable us best to determine the true amount of intentional deflection or of deflection due to a different cause. Thus, if Mr. Bilson "willingly accepts" 5 inches as the amount of recession in the south-east crossing pier, it would wonderfully accelerate the conviction of rapid readers as to my general contention, if he would refrain from publishing a cut which represents it as perpendicular, and if he would refrain from publishing alarmist pictures of fissures related to a bulge of 3 inches which has nothing to do with the case, provided that case be agreed upon as 5 inches recession, *without including the bulge.*

The most special point of the matter has, however, still to be considered. If an undoubted buckling has occurred, as in the south-east crossing pier, then it follows, although the estimate for the widening from base to cap is not affected, that our ability to determine where the inclination originally began, *is* affected. For the bulge which increases the backward inclination also carries its beginning higher up, obliterating our perception as to how low the inclination may have been before the bulge came in play. Therefore, instead of laying alarmist stress on the fissures in Rejoinder fig. 8, also apparent in fig. 2, we should consider that the corresponding fissure in fig. 3 is only responsible for $\frac{3}{8}$-in. bulge, or none at all.

That the backward recession begins below the triforium and at the height of the arcade capitals, in the crossing piers as well as in the piers of the nave, is what the original of fig. 3 was taken to show. Now comes the point which not a single engineering expert, who has examined the original enlargement, has contested. A vaulting thrust from the high altitude of the crossing meets, below the triforium, the resistance of the walls and *of the thrust* of the transept arcades, just as it meets the resistance of the triforium wall and clerestory wall above the triforium; but this resistance below the triforium is impregnable to an action from so great a distance and so great a height, when operating in so delicate a line of inclination. We should have to assume that the solid arcade masonry, between the triforium and the level at the base of the photograph in fig. 3, had the consistency and elasticity of soft india-rubber, if thrust from the high vault had produced the backward inclination

* Measured by me at 3 inches, and omitted by the Cathedral office drawing. Mr. Bilson's rather vague acquaintance with the recent observations which he has willingly accepted as correct is remarkably illustrated by his attempted defence of the Cathedral office drawing which made this omission. The Rejoinder admits (p. 85) that a northward bulge (photographically measured at 3 inches; see table) exists in the south-eastern crossing pier, and that this bulge is not entered on the corresponding drawing; but it suggests that the "lower part" of this pier "was not actually plumbed." Mr. Bilson also says (p. 85): "According to this drawing the greatest divergence on the northern face of the south-eastern crossing pier is 5 inches, and Mr. Goodyear now admits this to be correct." Quite the contrary; I do not at all admit this to be correct, and a moment's reflection on Mr. Bilson's part would have prevented him from making such a statement. The "greatest divergence" is, of course, 8 inches; for the Cathedral office drawings figure from the most advanced faces of the piers, including bulges, whereas my measure of 5 inches is figured from the bases, excluding bulges. Mr. Bilson's effort to defend the drawing on the ground that "it is probable that this lower part was not actually plumbed" thus involves an oversight of the mistake higher up, which is expressly mentioned in my first Reply. See requoted footnote in this Paper, and also p. 43 of first Reply: "The upper measure is to be corrected from 0.125 to 0.20."

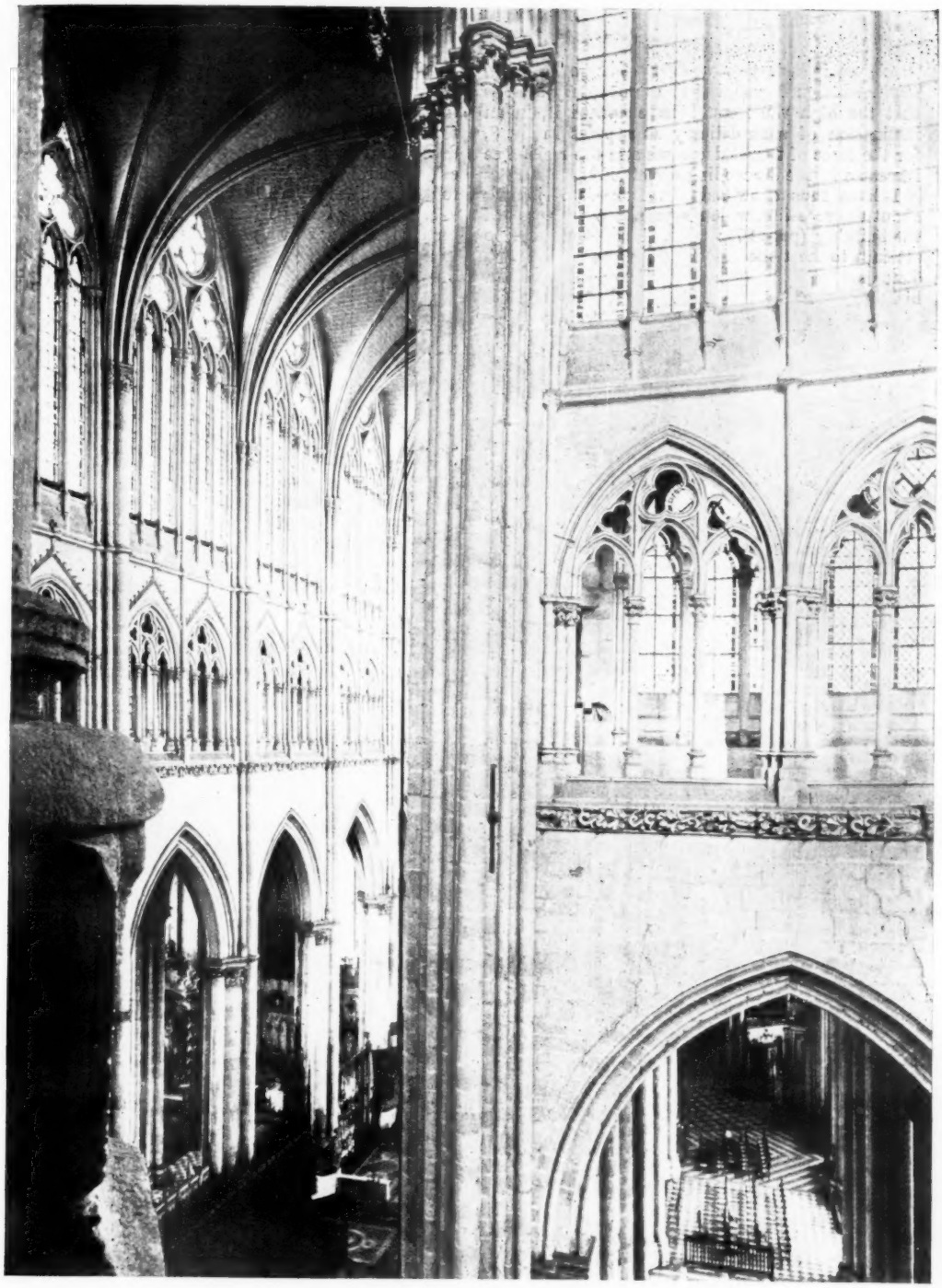


FIG. 2.—CABLE PLUMB AT THE S.E. CROSSING PIER.

From a Brooklyn Museum enlargement, Series of 1907. The plumb-line has been strengthened. From the level of the triforium down, the cable was wound with black and white tape, which gives it a slightly thickened appearance in the lower part.

as shown in this photograph. The lower down the inclination begins, the less probability there is that the high vault could have caused it, in an inclination of such delicacy as appears in fig. 3, for the force of thrust decreases and the resistance increases in the descending direction.*

I have thus answered Mr. Bilson's Rejoinder about the crossing, which says about that part of the building (page 87): "Mr. Goodyear makes no attempt to meet the historical and structural evidence set forth in my Paper, which is dead against his theory of intentional deflection." My answer is that, as far as the transept fissures, iron cable, and buckling of piers are concerned, the historical and structural evidence does not affect the measures which Mr. Bilson has accepted.

My answer is, furthermore, that fig. 3 supersedes all arguments of the original Criticism based on the condition of the high vaulting of the crossing. The facts are conceded, but their pertinence is denied, since no estimate of the amount of movement which they are supposed to indicate has been offered.† Furthermore, Mr. Bilson "agrees" in his Rejoinder (page 89) to my claim that "if the vaulting arches have gone down they must have become distorted, and if they have been distorted, that distortion must be visible." Why then does he not indicate the distortion in the transverse crossing arches 15, 16; 17, 18, [fig. 1] which ought to have resulted from 10 inches accidental widening —considering that he has catalogued all the distortions of the vaulting ribs which were visible to him (page 89)? *

II.

A few words must now be given to Mr. Bilson's theories of the transept fissures, for such an introduction will best enable us to rate at their true value his theories about the cracks in the nave.

Every architect, as well as every student of Viollet-le-Duc, is supposed to know that there are causes of irregular settlement, and of consequent masonry dislocation, which were inevitably, or actually, general in cathedral construction, which were due to the unequal compression of the mortar beds and which were wholly independent of thrust. Where the loading is heaviest, or the masonry courses and mortar beds are more numerous, the compression and consequent subsidence are greatest.† If the mortar beds of the crossing piers were compressed more than those of the neighbouring piers and neighbouring walls, as they undoubtedly were,

* Mr. Bilson argues in his Criticism (p. 414) that the Cathedral office drawings of the two southern crossing piers prove that: "The profiles of the piers cannot properly be described as 'curves' at all; rather they are broken lines which are the perfectly natural result of the movements which have caused them." This argument exhibits a pardonable but unfortunate ignorance of the methods of Greek curve construction, for the curves of the Parthenon are also constructed in broken lines. At both the east and west ends of the Parthenon the curves of the stylobate are constructed in four straight lines, with three bends on each side of a central bend. The curves of the architraves are constructed in four straight lines, with three bends on each side of the central straight line. (See Penrose, *Principles of Athenian Architecture*, plates 10, 11.) The Cathedral office drawing figures the north face of the south-eastern crossing pier as having four straight lines and three bends, and the accidental bulge is not figured. Thus, if the Cathedral office drawings were to be accepted as accurate records (which they are not), they would prove that vertical curves exist in the Amiens crossing piers which closely resemble the horizontal Parthenon curves. My own present observation of fig. 3, and of its enlargement original, is that the pier recedes in a straight line like the vaulting shafts in the nave (see fig. 13). My latest observations at Rheims also indicate that the effect of a curve may be obtained in a vertical line by a single bend. That the unassisted eye does not readily determine where a single bend begins is also proven by the hitherto unsuspected fact that all the vaulting shafts of the Amiens nave bend outward at the same point, directly above the capitals.

† For instance, page 414 of the Criticism appeals to partings (fig. 14 of this Paper), which appear on the wrong side of the northern and southern crossing arches, according to the premises of its own argument. If the partings quoted had been caused by north and south vaulting thrust from the crossing, operating on the piers and the north and south ribs which connect them, such partings ought to appear on the south side of the northern arch and on the north side of the southern arch; but they appear on the sides next the transepts, where compression rather than parting would be expected, as far as the given movement is concerned. Moreover the iron collars at J.K., L.M. (fig. 14), inserted by Bruno Vasseur in 1806, are in the centre rib of the crossing vault, which goes from east to west. The Criticism (p. 409) quotes the fact that "certain voussoirs of the ribs of the vault had dropped to a sufficient extent to show a break of 3 inches between them and the adjoining voussoirs which had not so dropped." Quite so; but how can repairs in the centre vaulting rib, which goes from east to west, indicate that a north and south widening is due to thrust? If the collars J.K., L.M., were in the north and south centre rib Mr. Bilson's argument might command our attention. The same passage refers to "several cracks in the panels of the vault, the principal of which are approximately shown by the dotted lines on the plan" (fig. 14). How does Mr. Bilson know that these cracks are not ordinary dilapidations caused by moisture and subsequent freezing weather? How does he know that they were not caused by the downward subsidence of the crossing piers?

* Although the telephoto, fig. 11, does not include these ribs, other enlargements which do include them are numerous, and show them to be in the perfect condition which Mr. Bilson's own silence implies.

† *Dict.*, IV., page 157, page 170. The related accounts of dislocations caused by unequal compression of the mortar beds specify some as due to unequal loading, and others as due to the unequal compression, under equal loading, which results from the associated use of masonry supports of equal height but unequal number of masonry courses—the thinner courses being more numerous and involving more numerous mortar beds. Viollet-le-Duc's article on Construction gives much greater prominence and much more space to dislocations caused by unequal mortar compression than to those caused by vaulting thrust. The downfall at Beauvais is explicitly stated to have been due to these causes, rather than to vaulting thrust, which was only a contributory cause, after the ruin produced in the supports by unequal compression had occurred (v. IV., page 181).

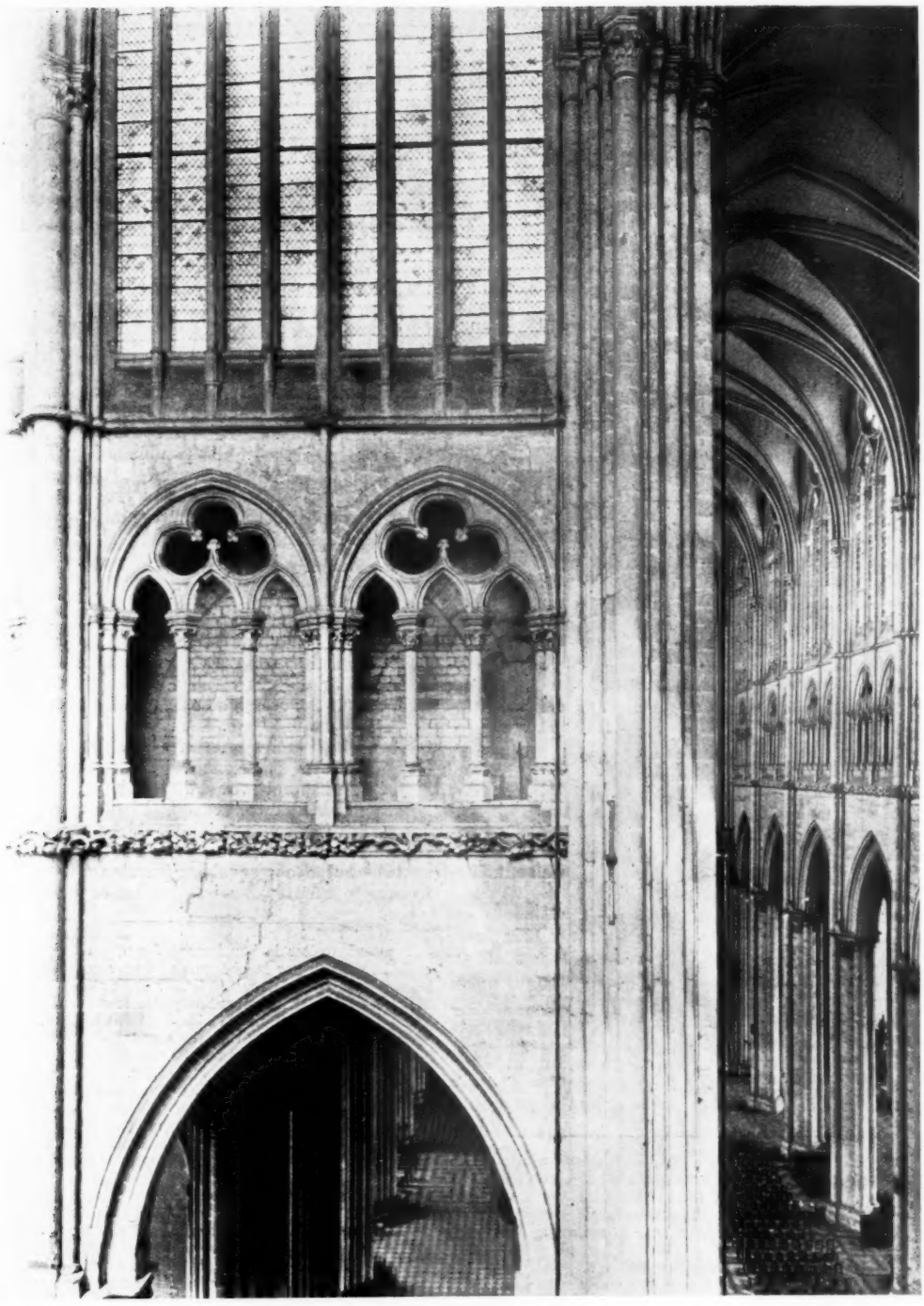


FIG. 3.—CABLE PLUMB AT THE S.W. CROSSING PIER.

The plumb-line at the left of the pier is a slender cord, suspended near the lens. From a Brooklyn Museum enlargement Series of 1907. The right plumb-line has been strengthened.

by the weight of the heavy crossing spire of early date, the masonry of the adjacent transept arcades and the triforium parapets would be necessarily thrown out of level, and fissures in these transept arcades and parapets would result.

Such fissures, incident to unequal compression and consequent unequal settlement, do not necessarily imply buckling, and they are not caused by thrust. Mr. Bilson's Rejoinder says, however (page 86), that "the cracks shown in fig. 8 decisively demonstrate" that "the lower deflections or bulges" . . . "are due to the thrust of the great arcades and aisle vaults." This amounts to ascribing the fissures to thrust, when subsidence was the essential cause. For instance, when last in Amiens I measured the subsidence of the parapet shown in Mr. Bilson's fig. 8 at 4 inches, whereas Mr. Bilson has only measured the width of the crack ($1\frac{3}{4}$ inches). The buckling on the same side is measured, by photographic methods, at 3 inches; but on the opposite side, shown by fig. 3, where the similar crack is quite obvious and the depression of the parapet level is very considerable, there does not appear to be any northward buckling whatever.

The same overloading might, and certainly did, produce the fissures caused by subsidence and promote the buckling, but overloading is not thrust. Thrust from the transept arcades and from the aisle vaults would promote buckling under the given conditions, and so might increase the width of the fissures; but thrust does not cause unequal subsidence, and unequal subsidence is notably apparent in these fissures.

The upshot of the matter therefore is this. In so far as the transept fissures are dislocations due to unequal subsidence, they are not due to thrust. That the dislocations caused by unequal subsidence are the essential cause of the fissures is apparent from the 4 inches subsidence measured in the south transept, east parapet, and from the depression in the level of the west triforium parapet in the south transept; but Mr. Bilson's publications allow and compel the public to infer that these fissures and dislocations are wholly due "to the thrust of the great arcades and aisle vaults."*

No doubt Mr. Bilson would reply that he has followed the account given by M. Durand and that this is the account of the Commission of 1498, which ascribed both the buckling and the fissures to thrust of the transept arcades and aisle vaults. I prefer, however, the authority of Viollet-le-Duc on questions of statics, which says that the iron cable was introduced to stop the buckling of the piers of the crossing *caused by the weight of the central tower before it was destroyed by fire.** It is self-evident that the limit of compressibility in the mortar beds of the crossing piers must have been reached before the buckling occurred, and consequently that fissures due to subsidence must have existed before buckling took place, because they exist in the south transept, west arcade, where no northward buckling has happened. As for the report of the fifteenth-century Commission, it is evident that the intent was to show the need of the iron cable and to quote the most obvious dilapidations which made it necessary, rather than to give a philosophical account of all the causes of these dilapidations. Therefore the account thus given of the origin of the trouble need not detain us simply because M. Durand has followed it. The main thing in the mind of the Commission was to show that both the fissures and the buckling made the cable necessary.

III.

It might appear that this discussion of the cause of the transept fissures is academic and unnecessary. Since it has been shown that the bulges at the crossing do not affect the measures for the widening at the crossing or the problems connected with them, it may be asked: Why is it necessary to distinguish between fissures due to thrust and fissures due to subsidence? My answer is that Mr. Bilson has not proved *any* of the cracks in the building to be due to thrust, and he has uniformly overlooked the cause which would be most likely to produce them—viz. unequal and parallel vertical subsidence due to unequal compression of the mortar beds. To concede, by implication or by silence,

* It must be agreed by all parties that wherever vertical subsidence has occurred at Amiens it has been due to the unequal compression of the mortar beds and not to the yielding of foundations. The wholly remarkable gridiron foundations at Amiens have been described at length by Viollet-le-Duc (*Dict.* iv. p. 175). They have also been described by M. Durand (vol. i. p. 202) as: "Aussi colossales que le monument lui-même. Construites à la manière d'un immense radier, elles assurent à celui-ci une assiette inébranlable et une solidité de nature à défier toutes les causes de destruction."

* "Pour arrêter le bouclement des quatre piles de la croisée fatiguée par la charge de la tour centrale, avant l'incendie de cette tour" (*Dict.*, v. II., p. 404). Even if M. Durand be right in supposing this tower to have been of timber (in opposition to Viollet-le-Duc, who held it to be stone) it does not follow that the tower had no weight, or was not a heavy extra load on the crossing piers. This is the rather inconclusive reasoning of Mr. Bilson at page 405 of his original Paper. The fact that the tower had great weight is shown by a subsidence which can have had no other cause. The fact that the next adjacent transept pier, 18*b*, leans 3 inches against northward thrust (enlargement exhibit 55, new series) *and does not taper*, is significant, for it proves that northward thrust, if active at all, was limited strictly to the one arcade, 18*a*, *b*. The pier 16*b* leans against northward thrust (enlargement exhibit 55, series of 1903). The pier 17*b* leans against southward thrust (enlargement exhibit, series of 1905). The pier 15*b* leans against southward thrust (enlargement exhibit 59, series of 1903). Thus it appears for all four transept arcades next the crossing, that whatever thrust toward the crossing was in question was confined to the arcades next the crossing piers.

that the transept cracks have been primarily caused by thrust from the transept arcades is to overlook the cause which undoubtedly, and mainly, did produce them. The inquiry thus becomes pertinent: Was it thrust (as held by the Rejoinder), or was it subsidence, which caused the cracks in the arcades of the nave?

The distinctions in the two cases are obvious. In the transepts Mr. Bilson ascribes the arcade cracks to arcade thrust operating in the line of the arcades below the triforium. In the nave he ascribes arcade cracks of similar nature and also evidently lateral in the line of the arcades, but of much less serious character, to vaulting thrust at the lofty height of the nave, not operating laterally in the line of the arcades, but operating at right angles to that line down to points below the triforium. In the transepts he had some published authority in his favour, although higher published authority and sound argument are against him. In the nave the arcade cracks have already been elaborately published by M. Durand, without the remotest suggestion in that publication that thrust from the nave vaulting caused them. In the transepts, the worst fissure in the building, of $1\frac{3}{4}$ inches in width, is held by Mr. Bilson to explain a movement in the line of the arcades of 3 inches. In the nave much less serious cracks (not fissures at all) are held to explain a movement of $19\frac{1}{2}$ inches.

Who can doubt that Mr. Bilson selected for publication in his Rejoinder a photograph of the worst fissure that he could find in the building? The photographs to follow in this Paper will prove it. If he could measure a lateral crack in the transepts of $1\frac{3}{4}$ inches, why could he not measure some of the cracks which, on his theory, call for a total of $19\frac{1}{2}$ inches of *transverse fractures* in the upper nave?* For here we must distinguish between a lateral crack and a transverse fracture. For Mr. Bilson's theories they are all "cracks," and not a word is vouchsafed either as to measures or as to whether the cracks are lateral or transverse.

Thus the elementary distinction, just indicated for the transept fissures, between movement and dislocation caused by thrust, and movement and dislocation caused by unequal subsidence, now leads me to illustrate and describe the cracks in the masonry of the nave, which are supposed by the Rejoinder to give the *coup de grâce* to the theory of a widening refinement at Amiens.

All these cracks have, as just mentioned, been catalogued by M. Durand,† but they were not explained by him as caused by an accidental widening of the nave, which is the explanation now given of them by Mr. Bilson. Moreover, when Mr. Bilson published his first Criticism, and when the nave widening was supposed by him, and therefore presumably by M. Durand, to be "certainly not greater" than 7 inches, "and most probably much less,"* these cracks were not invoked. Now they are sufficiently elastic to account for the $19\frac{1}{2}$ inches widening which Mr. Bilson now willingly admits to exist in the western part of the nave. The question thus presents itself: If the cracks already known to Mr. Bilson and already published by M. Durand will so easily account for $19\frac{1}{2}$ inches accidental widening in the nave, why did their known existence not lead M. Durand and Mr. Bilson to anticipate the existence of such a widening? The answer is that these cracks do not easily, or even possibly, explain any widening whatsoever, for they

FIG. 4.—CRACK IN THE EASTERN SPANDREL OF ARCADE 2, 4, WEST END OF THE NAVE, SOUTH SIDE.
From a Brooklyn Museum photograph, Series of 1907.

* Nineteen and a half inches is the measure "willingly accepted" by Mr. Bilson for the widening in the western nave at 5, 6 (fig. 1). Observations could easily be made at close range along the exterior clerestory parapets for any transverse fractures there existing, and such fractures could be easily observed from that level as increasing higher up. Transverse fractures could not be concealed by repairs. The change of surface would always be apparent.

† *Monographie*, I, page 61.

* The widening for the south-west pier was figured by the Cathedral office drawing at $3\frac{1}{2}$ inches (excluding bulge). I have figured Mr. Bilson's original views about the maximum widening in the nave at double that amount, "or most probably much less."

are lateral cracks in an east and west direction, and not transverse fractures in a north and south direction, such as are called for by Mr. Bilson's theory. This will be abundantly shown from photographs now to be quoted and reproduced.

Fig. 4 shows the crack in the arcade 2, 4 (plan, fig. 1), quoted by Mr. Bilson (page 88), on the south side of the nave between the 6th pier (in my numbering) and the tower pier. Fig. 5 shows the similar crack in the arcade 1, 3, quoted by Mr. Bilson (page 88), at the corresponding point on the

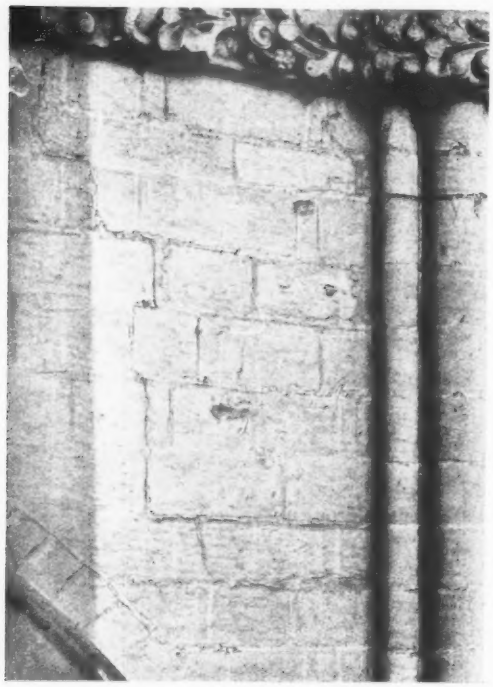


FIG. 5.—CRACK IN THE EASTERN SPANDRIL OF ARCADE 1, 3, WEST END OF THE NAVE, NORTH SIDE.

Detail from a Brooklyn Museum enlargement, Series of 1907.

north side. As soon as illustrated, these cracks are visibly due to a slight vertical subsidence of the piers 3, 4, which was slightly greater than that affecting adjacent parts of the structure, all of which were bound to settle, by compression of the mortar beds, as explained by Viollet-le-Duc in the passages referred to in footnote (page 720). A gradual descent of the cracks, step fashion, in the direction from west to east will be noticed on both sides (figs. 4, 5). This, taken with the fact that the eastern spandrils are the ones affected, shows that it is the piers 3, 4, which have gone down, as compared with 1, 2, and not the reverse.

On page 88 of the Rejoinder it is argued, since the tower piers are perpendicular throughout their height, whereas the following piers are perpendicular only to the arcade capitals, that these piers, which lean outward above the arcade caps, must therefore have caused an accidental twist in plan, beginning in the spandrils, including them, and continuing above them. That a twist in plan must exist I heartily agree. Is this twist accidental, and do the quoted cracks prove it to be accidental? The following quotation is from page 88 of the Rejoinder:—

> "*What has the structure to tell us? In the western bay, 1, 3, there is a pronounced crack in the eastern spandril of the main arcade, and there are cracks through both arches of the triforium, extending upwards through the sill of the clerestory window; there is also a crack in the relieving arch in the thin wall at the back of the triforium of this bay. In the bay 3, 5, there are slight cracks in both spandrils of the main arcade and also in the western spandril of the bay 5, 7. The south side tells a similar story. In the western bay, 2, 4, there is a crack in the eastern spandril of the main arcade, extending through the triforium parapet, and there is a corresponding crack in the tracery of the eastern half of the triforium.*"

This apparently formidable catalogue of cracks is italicised in order to emphasise Mr. Bilson's alarmist methods and his disposition to indulge in elaborate literary descriptions of other similar dilapidations, which amount to nothing for his argument when examined. One can hardly realise how hollow and shallow this paragraph is, until we examine the photographs. Take, for instance, fig. 4, for arcade 2, 4, just quoted by Mr. Bilson for the crack in the eastern spandril. If this were not a vertical crack, due to unequal subsidence, it would show a fracture stepping back on the line of the crack with a change of surface amounting to $2\frac{3}{4}$ * inches abrupt backward break at the string course. But the surface of the spandril is seen to be a plane surface.

Take again, for instance, fig. 5. The crack there shown in the bay, 1, 3, is a vertical crack due to unequal subsidence. If it were due to an outward movement resulting in a transverse fracture of the wall, we should be aware of it in the surface of the spandril, as shown by fig. 6, and also by fig. 2 of the first Reply. The surfaces are, however, smooth and plane. How clearly visible $3\frac{1}{8}$-inch transverse fracture† would be on fig. 6 may be estimated from the flat moulding under the decorative carving of the string course, which projects from the wall about 2 inches. On Mr. Bilson's theory this moulding ought to exhibit a

* The photographic measurement for recession in the given height of the given vaulting shaft is $2\frac{3}{4}$ inches.

† The photographic measurement accepted by Mr. Bilson, for the recession in the given height of the given vaulting shaft, is $3\frac{1}{8}$ inches (not $2\frac{3}{4}$ inches as supposed by him). The true measurement may be computed from the disc in fig. 2 of my first Reply.

backward fracture equal in amount to $1\frac{1}{2}$ times its own projection.

Mr. Bilson should undoubtedly be able, according to his theory, to point out on these photographs (figs. 5 and 6) an abruptly receding surface, following the line of fracture shown by fig. 5, and showing $3\frac{1}{8}$-inch abrupt transverse and receding fracture

FIG. 6.—EASTERN SPANDRIL OF ARCADE 1, 3, WEST END OF THE NAVE, NORTH SIDE, SHOWING A PLANE SURFACE, WITHOUT TRANSVERSE FRACTURE.

Detail from a Brooklyn Museum enlargement, Series of 1907.

at the string course. Nothing of this kind appears. Why not? Because Mr. Bilson has tried to explain an unequal vertical subsidence, due to unequal compression of the mortar beds, as the result of a transverse movement produced by vaulting thrust operating from the top of the nave. It is useless to say that the cracks have been pointed up or filled in. If they have been so filled in, an abrupt change of surface would still be visible.

Let us now pass inside the triforium and examine the corresponding cracks in the triforium wall, which are appealed to as evidence of vaulting

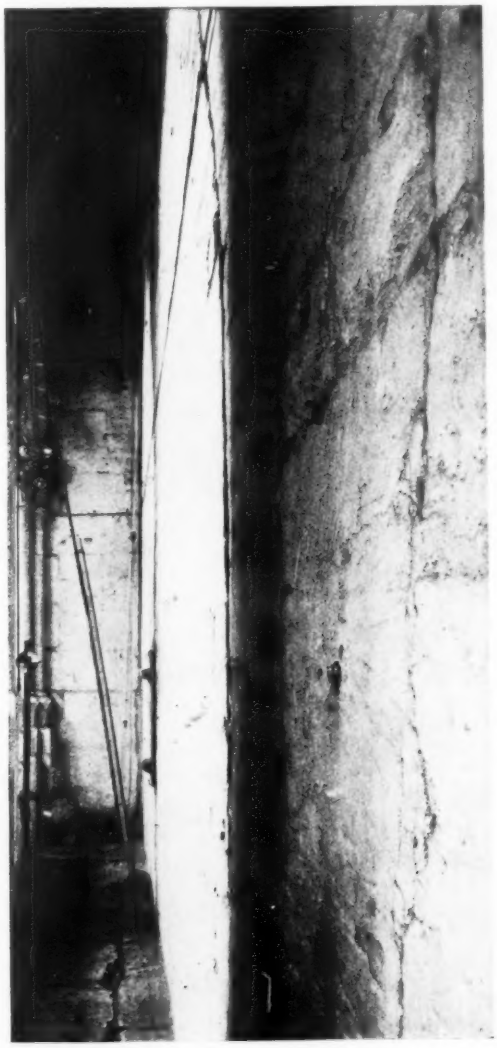


FIG. 7.—CRACKS AT THE WEST END OF THE TRIFORIUM WALL, NORTH SIDE (BAY 1, 3). THE DIAMETER OF THE DISC ON SURVEYOR'S ROD (CONSIDERABLY BEYOND THE PLANE OF MEASUREMENT) IS $5\frac{1}{2}$ INCHES.

From a Brooklyn Museum enlargement, Series of 1907.

thrust (fig. 7). On Mr. Bilson's theory the farther crack seen on the right hand in the cut should represent a fracture in the wall with an abrupt outward break of $3\frac{1}{8}$ inches *at the triforium pave-*

FIG. 8.—THE CLERESTORY, WEST END OF THE NAVE, NORTH SIDE, SHOWING A CRACK OVER THE TRIFORIUM ARCH, AND IN THE WINDOW SILL, OF BAY 1, 3; ON THE EXTREME LEFT ALSO SHOWING THE CONDITION OF THE SILLS, AS REGARDS CRACKS, OF BAY 3, 5.

Detail from a Brooklyn Museum enlargement, Series of 1907.

ment, and this outward break should amount to $6\frac{3}{4}$ inches at the top of the triforium wall.* Nothing of the kind appears. Although there are two cracks rather than one, as mentioned by Mr. Bilson, his case would not be bettered by dividing the fractures called for between the two. (The circular disc on the rod beside the triforium parapet has an outside diameter of $5\frac{1}{2}$ inches, but is considerably beyond the planes of measurement.)

Fig. 8 shows the crack, continuing the one seen in fig. 5, through the triforium arch and through the sill of the clerestory window, as mentioned by Mr. Bilson. On Mr. Bilson's theory the crack in the window sill ought once more to be an outward fracture of $6\frac{3}{4}$ inches and upwards, but no such fracture appears. Fig. 8 also includes the next bay, 3, 5, and ought to show fractures of $1\frac{3}{4}$ inch in the window sills above the triforium arches in that bay.† But no cracks at all are quoted for this bay above the triforium and none worth mentioning appear. Those quoted for 3, 5 in the spandrils are too insignificant for illustration; the enlargement from which fig. 8 is taken shows one of these cracks, and shows both spandrils with plane surface.

The next illustration, fig. 9, carries us to the exterior parapet on the north side, at the base of the clerestory, which is the ceiling of the triforium, designated by M. Durand as the *galerie sans bords*. The level corresponds to that just under the windows in fig. 8. A surveyor's rod (disc 8 by 10 inches) leans against the column. Consider that the middle colonette of the pier is about 8 inches in profile diameter. Consider that a forward break in the masonry of the window sill, of $6\frac{3}{4}$ inches, and nearly equal in amount to the profile diameter of this colonette, is called for at this point by Mr. Bilson's theory. It need hardly be mentioned that no possible repairs could conceal exterior breaks of the given character and extent.* If such breaks existed it would be incredible that they had not been mentioned by M. Durand. It is no less surprising that Mr. Bilson neglects to state that he has inspected these easily accessible points with a view to the observation of fractures.† It is much more convenient and much more convincing to have fractures under your very feet than it is to inspect them at a lofty height in the interior from the pavement of the nave. However, if such breaks really existed, it would not have been left to Mr. Bilson to find and explain them, or to me to inspire Mr. Bilson with the thought that they ought to exist. On the contrary, the $19\frac{1}{2}$ inches widening at 5, 6 would in that case be a matter of ancient history, embalmed in M. Durand's exhaustive work as known for many generations.

An illustration similar to fig. 9 is available, though not published, for the *galerie sans bords* on the south side of the Cathedral, showing the exterior window sill 2, 4. Here a transverse fracture of $5\frac{1}{4}$ inches ‡ is called for by Mr. Bilson's theory, but the sill shows neither fractures nor cracks.

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* $3\frac{1}{4} + 3\frac{5}{8}$ inches. The total recession of the sixth pier (No. 3, fig. 1) is $7\frac{1}{2}$ inches (see table of measures accepted by Mr. Bilson). This estimate is obtained as follows (see requoted explanations, page 717):—

	Inches
Plumb from triforium to arcade cap, with photographic measurement, by surveyor's rod disc, on desired plane	$3\frac{1}{8}$
Triforium inclination, estimated for 24 feet from actual plumb of foot decimal 0·20 with line of 15 feet	$3\frac{5}{8}$
Clerestory vaulting shaft, estimated for height of 13 feet 4 inches from the same plumb	$1\frac{3}{4}$
	$8\frac{1}{2}$
Subtract an inch for projection of the vaulting shaft beyond the pier at arcade cap	$7\frac{1}{2}$

This subtraction is necessary in order that the combination estimates may start from the same surface as the single measures for recession from base to vaulting, obtained by other enlargements for three piers of the north side (see table). These measures start from the surface of the perpendicular pier at the base. The combination estimates, from measures actually taken in detail, are each increased by an inch, because computed above the arcade capital, and because the vaulting shafts project an inch on the north side. On the south side only one vaulting shaft so projects (No. 4, fig. 1), and subtractions are not necessary.

† Pier 3.—

	Inches
Disc measurement from arcade cap to triforium string	$3\frac{1}{8}$
Triforium plumb estimate for 24 feet, at the rate of 0·20 in 15 feet	$3\frac{5}{8}$
	$6\frac{3}{4}$

Pier 5.—

Disc measurement from arcade cap to triforium string	$3\frac{3}{4}$
Triforium plumb estimate for 24 feet, at the rate of 0·25 in 15 feet	$4\frac{3}{4}$
	$8\frac{1}{2}$
Excess recession for vaulting shaft of pier 5, at level of triforium ceiling	$1\frac{3}{4}$

It must be remembered that 2 inches out of 12 inches total measure for recession at pier 5 are credited to constructive stepping back of the clerestory vaulting shaft (see explanations of first Reply, page 47, and also page 733 and fig. 12 of this Paper), and these 2 inches cannot be figured for fractures.

Mr. Bilson's own calculations would call for a total of $4\frac{1}{2}$ inches transverse fractures in this bay at the springing of the vault, but his case is not bettered by reduction to a total of $2\frac{1}{2}$ inches.

* The platform itself is covered with lead, but the sill is not, and the outer edge of the platform is not broken.

† He reports on the flying buttress at 3*a*, *b*, and must have been at the very spot, unless this observation was made from the less convenient aisle roof lower down.

‡ Pier 4.—

	Inches
Disc measure from arcade cap to triforium string	$2\frac{3}{4}$
Triforium plumb estimate for 24 feet at the rate of 0·13 in 15 feet	$2\frac{1}{2}$
	$5\frac{1}{4}$

The failure of the Rejoinder to make any report whatever of observations for cracks along the *galeries sans bords* is in curious contrast with the positive dogmatism of its list of cracks lower down. Clearly the fractures in transverse direction, which are called for by Mr. Bilson's theories, should increase in measurement with the height and with the increase of accidental inclination. Moreover, on these parapets the observer is in direct contact with the masonry. He can touch it with hands and feet. It is close to his eyes. Why is it, then, that the catalogue of cracks stops where it ought to begin? The following answer is an ultimate point-blank overthrow of Mr. Bilson's theory.

FIG. 9.—THE GALERIE SANS BORDS, NORTH SIDE, LOOKING EAST.

From a Brooklyn Museum enlargement. The sill of window 1, 3, is on the right. The line to which the measurements of the constructive bend in plan were taken, is stretched at equal distances from the columns at opposite ends of the parapet. The photograph shows the sill without fracture. It also shows the bend in the alignment of the columns and on the outer edge of the parapet.

Mr. Bilson is quite right in his perception that there must be a twist in the plan of the cathedral at and above the level of the triforium, considering that the tower piers are perpendicular and that the others are inclined. His difficulty is that he did not take measurements for constructive bends in plan in the *galeries sans bords*. If he had done so his theory would have died in birth. Fig. 9 shows the line stretched from one extremity of the parapet to the other which was used in taking the measurements for a constructive bend in plan. Even in the small dimensions of fig. 9 the curve can be seen in the outer edge of the parapet and in the alignment of the columns. A similar unpublished illustration is extant for the south side.

IV.

The question has been, so far, left open, as to the special cause of the vertical subsidence which produced the cracks in the arcades of the nave at the eastern spandrils of 1, 3; 2, 4 [figs. 4, 5, &c.]. Mr. Bilson's theory of these cracks, that they were caused by vaulting thrust from the high nave, now appears to be not only mistaken and false, but even quite reckless, considering that the facts which are illustrated by the figs. 4–9 inclusive, were easily within the limits of his own observation and lay, in some cases, at his very feet, in several parts of the cathedral. Therefore it might appear that any further discussion of the causes of these spandril cracks would be quite academic and an unnecessary expansion of the controversy. At all events the probable cause might appear to be an unequal compression of the mortar beds, as between piers 1 and 3 and piers 2 and 4.

It happens, however, that the most important, if not the only, cause of these cracks was that which produced the fractures in the triforium lintels [fig. 10, E]. As the Rejoinder argument (page 88) about these lintels is altogether its most curious and astounding feature, the discussion of the true cause of the spandril cracks becomes necessary, as connected with the question of the lintels.

Viollet-le-Duc has pointed out that the downfall at Beauvais was not, primarily, due to vaulting thrust. It was the result of a daring development of a system of support found at Amiens, and thence borrowed.* This was the system of combining

* *Dict.*, IV., pages 170, 171, with illustration.

columns composed of monolithic drums, placed *en délit* (cleavage upright), with the piers of ordinary masonry construction. This system at Amiens is shown by fig. 10, in which the supports at the heads of the flying buttresses are cylindrical columns (monolithic in cross section and with blocks *en délit*), one placed above the other; the lower one resting on the triforium wall, while the inner piers support the main load of the vaulting.* Viollet-le-Duc's article on Construction has explicitly described and illustrated this system of support at Amiens, and has explicitly explained the function and nature of such columns, composed of blocks placed *en délit*. Cylindrical columns, composed of monolithic drums, are naturally built of fewer blocks than are used in the masonry of piers, and to obtain the desired greater height in the drums they are placed *en délit*—that is, with the "beds" or cleavage upright. The object is to obtain a more slender and a more rigid support than that offered by masonry piers, because the mortar beds being less numerous than in the masonry piers, the settlement due to compression of the mortar beds is correspondingly diminished.

At Beauvais, when the interior piers settled, as result of the drying out of the mortar beds,† the colonettes *en délit*, which did not settle as much as the piers, for reasons explained, could not support the consequent loading (not thrust) which was thrown on them. They were broken down by the overloading and gave way. Hence the weight and thrust of the vault came entirely on the heads of the flying buttresses, and the disaster followed. It is distinctly stated that the enormous edifice would have preserved a perfect stability if the columns *en délit* at Beauvais had been of better building stone, and that the logic of the construction was perfect. It was poor material which was at fault.‡ This recital shows the importance attached by Viollet-le-Duc to the unequal compressibility of mortar beds, due in this instance to the juxtaposition of columns *en délit* with piers of ordinary masonry and more mortar beds, and his opinion that vaulting thrust was not the primary cause of disaster at Beauvais.

* The distinction between loading and thrust has to be considered here. Viollet-le-Duc's theory of Gothic construction is that of a pier so rendered rigid by its loading that the aisle thrust inward below, and the nave thrust outward above, neutralise one another. The nave thrust is thus converted into loading, unless the equilibrium is disturbed, and only then are the flying buttresses needed. *Dict.* IV., page 74, "L'arc boutant est simplement un obstacle opposé non point aux pressions obliques, mais à leur effet si l'equilibre venait de se déranger."

† *Dict.*, IV., pages 180, 181: "Les désordres qui se sont manifestés dans la construction sont venus tous de là; ces colonettes, trop grêles, se sont brisées, car elles ne pouvaient résister à la charge qui se reporta sur elles, lorsque les piles intérieures vinrent à tasser *par suite de la dessiccation des mortiers.*"

‡ *Dict.*, IV., pages 174, 175.

At Amiens the unequal compressibility of the columns *en délit*, and of the associated piers, has only resulted in the fracture of a certain number of lintels in the triforium, due to the unequal and greater subsidence of the piers, and this subsidence is not only due to the greater number of mortar beds, but also to the fact that the piers support the main loading of the vaulting.* This cause of the fractured lintels at Amiens has been described by M. Durand, in conformity with the explanation just offered, and in a passage which I have quoted in my Reply.

Mr. Bilson's Criticism attributed the fractured triforium lintels to the vaulting thrust (page 410). In my Reply I quoted the wholly different and correct explanation given by M. Durand, suggesting that Mr. Bilson had overlooked it, and I will now quote it again†: —"*La compressibilité des parties intérieure et postérieure du pilier se trouvant inégale par suite de la rigidité de la colonne G, qui est en délit, un certain nombre de linteaux E se sont brisés.*" M. Durand's footnote thus says that the compressibility of the interior and posterior parts of the supports, being unequal, on account of the rigidity of the column G, which is built *en délit* (H is, of course, to be included), a certain number of lintels were broken in consequence. But Mr. Bilson's Rejoinder says: "La

* The unequal and slightly greater subsidence of the piers, as compared with the exterior buttresses, was even foreseen and desired at Amiens. See *Dict.*, IV., page 170, for illustration and reasons of statics connected with the action of the buttresses.

† *Cathédrale d'Amiens.* Georges Durand. Tome 1er, page 222, note.

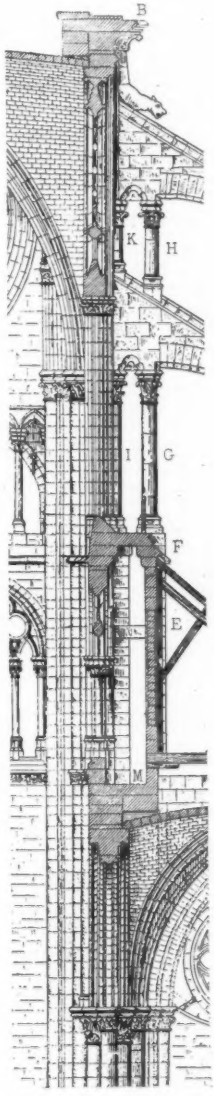

FIG. 10.—DETAIL FROM THE SECTION OF THE CATHEDRAL, AS PUBLISHED BY DURAND (PLATE VIII.), WITH THE LETTERING USED IN HIS EXPLANATION OF THE FRACTURES IN THE TRIFORIUM LINTELS.

compressibilité des parties antérieure et postérieure du pilier se trouvant inégale" implies movement, "*and this movement can only have been caused by the thrust of the nave vault.*" * Now comes an even more astonishing statement: "I have M. Durand's authority for saying that he entirely agrees with me on this point." In that case Mr. Bilson has M. Durand's authority for stating that a dislocation caused by unequal compressibility of the masonry can only have been caused by vaulting thrust—*i.e.* by another cause than the unequal compressibility of the masonry.

Fortunately, M. Durand's original statement needs no explanation, and Viollet-le-Duc's authority will replace his own, if he retracts or modifies it. Thus, presuming that the unequal subsidence of certain piers of the nave in the Cathedral of Amiens has been properly explained by Viollet-le-Duc, if not by M. Durand, it only remains to inquire whether the triforium lintels of the piers 3 and 4, beside which the spandril cracks occur, are among those which exhibit the debated fractures. If such fractures are found in the triforium lintels of piers 3 and 4, the spandril cracks are also explained by the same settlement. Fortunately the Rejoinder can be quoted for pier 4.† As for pier 2, the fracture is shown by an enlargement exhibit, one of nine for the triforium (with camera back of the position taken for fig. 7).

Mr. Bilson's controlling idea that "movement" in a cathedral must always be explained by "thrust of the nave vault" is very explicitly illustrated in the preceding paragraphs, and these paragraphs categorically challenge and contradict this opinion.

V.

We are now prepared to examine the Rejoinder's elaborate account of the cracks and distortions in the nave vaulting; for the same dislocations which caused the spandril cracks and the fractured lintels must necessarily explain many of the cracks in the wall cells of the vaulting. The well attested percolations of water in various parts of the vaulting, followed by frost and the expansion of the joints produced by ice, would explain others. Of the cracks and distortions of the nave vaulting Mr. Bilson has given a catalogue, covering, with his discussion of them, two columns and a half (pages 88, 89). No doubt the effect is imposing for the rapid reader, and calculated to give pause to experts, who will doubtless hold their opinions in suspense until some reply is made.

Now what is the matter in debate? It has recently appeared that the widening in the Amiens nave is very considerably greater than has ever been previously supposed, either by Mr. Bilson, or by anyone else. The measures accepted by Mr. Bilson total as follows:—

Widening of the Amiens Nave.

	Inches
First bay (13, 14)	12
Second bay (11, 12)	$14\frac{3}{4}$
Third bay (9, 10)	16
Fourth bay (7, 8)	$15\frac{1}{4}$
Fifth bay (5, 6)	$19\frac{1}{2}$*
Sixth bay (3, 4)	14

Up to the date of my Reply the least recession at the crossing, north side, was supposed by Mr. Bilson to be $3\frac{1}{2}$ inches at the south-west pier, and the divergences in the nave were stated by him to be "certainly not greater and most probably much less."† Mr. Bilson also stated that "M. Durand has most kindly placed his intimate knowledge of the Cathedral at my disposal,"‡ from which we may safely conclude that M. Durand approved of Mr. Bilson's views on this head. Now Mr. Bilson is careful to assure us that he had noted the "very pronounced" cracks in the vaulting ribs and vault cells of the western bays (where he assures us that they are more prominent than elsewhere) "before I had seen Mr. Goodyear's Reply."§ Does it not therefore inevitably follow that he and M. Durand had formerly considered 7 inches an excessive allowance for the amount of accidental thrust which had caused these dilapidations? In the original Criticism these known dilapidations were supposed to result from an accidental widening of "most probably much less" than 7 inches. But now it appears that they will easily account for $19\frac{1}{2}$ inches. What is the explanation of this change in the state of affairs? It is a distressing illustration of Mr. Bilson's elastic methods of argument, and of his indifference to the exact relations of cause and result, to find that the same cracks and distortions which were once good for "much less" than 7 inches are now good for $19\frac{1}{2}$ inches. Naturally it is not necessary for me to do more than say that I am willing to make the same allowance for dilapidations which Mr. Bilson and M. Durand formerly thought sufficient, viz. something much less than 7 inches accidental widening, charging the rest to intentional construction. Or else it is incumbent on Mr. Bilson to state that he has discovered previously unnoticed dilapidations; but he expressly informs us that the most important ones, now elaborately described, were previously known to him.

In his Rejoinder (page 87) Mr. Bilson also quotes "the dilapidations described in the reports of Sambucy and Grandclas," but in his original Criticism

* *Italics* by W. H. G.

† "Some of the lintels over the triforium passage are fractured, among them that behind the pier 4" (page 88).

* Part of the disparity of measurement at this bay has been noted (footnote, p. 727) as due to a constructive and apparently experimental stepping back of 2 inches in the upper member of the vaulting shaft on the north side (fig. 12 and p. 733). As far as slopes are concerned, whether intended or accidental, they would figure 17 to $17\frac{1}{2}$ inches.

† Criticism, page 415.

‡ *Ibid.* page 401.

§ Footnote, page 89, Rejoinder.

he had already at great length* rehearsed the accounts given by M. Durand of the dilapidations reported by Sambucy and Grandclas. He had already then mentioned them as "frightful." If we had not read M. Durand's book we still knew, from the Criticism, about Grandclas' report of 1805, that: "In several bays the vaults are separated from the walls in such a disturbing manner that in many places it is possible to put the hand between the ogive and the wall," &c. In June 1906 we knew as much as Mr. Bilson told us in December 1907. In June 1906, 7 inches widening was "most probably" a good deal too much to allow for all this. In December 1907, 19½ inches is just about right.

Mr. Bilson says: "M. Durand tells me that he believes that the nave vaulting has been repaired, but that these repairs have been *comparatively slight*, as its condition did not need *extensive repair*." † Is there any expert who is prepared to say that repairs of fissures for the widenings just quoted could be called "comparatively slight"? Viollet-le-Duc says that the nave at Amiens "has never been distorted or thrust outward." ‡ Mr. Bilson says (page 89), about this quotation, that Viollet-le-Duc "was a practical man and must have known that the movement in the nave of Amiens was insignificant compared with that in some churches with which he had to deal." But what Viollet-le-Duc says is that there has been *no* perceptible movement. Moreover, I do not agree with Mr. Bilson that Viollet-le-Duc would have considered such fissures insignificant, or that he would have spoken of a church which exhibited such fissures as not having suffered from thrust (*ni déformée ni déversée*). Nor is Mr. Bilson quite ingenuous in suggesting that widenings of such amount were known, before my studies, to be common in French Gothic. M. Choisy may be presumed to have experience in this matter, and he says of the 20-inch widening at Rheims that the facts would appear to be improbable if they were not verified by photography. §

The rise of the transverse joints in the wall cells above a straight horizontal line is only 20 inches, in a clear width of 40 feet 10 inches. Thus almost the entire amount of widening at these joints would have to be figured for fissures. Now Mr. Bilson's account of the cracks in the wall cells is a curious anticlimax when the known facts are considered. He says (page 88) that "In some bays there is *more than one* such crack in the wall cell." Therefore, in some bays there is only one crack in the wall cells of a given side. But there is no point at which the widening at the joints of the wall cells is less than 12 inches, or 6 inches, more or less, to a side. Therefore, where Mr. Bilson saw only one crack, it must have been a single fissure (filled in, of course) of at least about 6 inches width, even in the minimum widening, which is absurd. *

Again; compare the report of Grandclas. It mentions fissures between the vaulting cells and the wall, into which the hand could be inserted, as the cases of most extreme gravity, in the way of fissures, which were known to him. Certainly such fissures, of possibly 1½ inch parting, ought to be a cause for grave alarm; but what an anticlimax this statement offers, when compared with the fissures which are called for when the theory of accident is applied to widenings of the now accepted amount. How could such fissures be reconciled with M. Durand's statement that the repairs of the nave vaulting have been "comparatively slight"?

Thus the Rejoinder's complaint (page 89) may now be noticed, that I "never mention the iron ties," which were inserted over the vaulting in the nave and choir by Grandclas. The reason is partly given by Mr. Bilson himself, who quotes M. Durand's remark † that the report of Grandclas which called for the iron ties "seems exaggerated," in spite of the fact that he was allowed to put them in. There is still another reason. Partings between the wall and vaulting, into which the hand can be inserted, ought to have caused serious alarm. Some movement must have taken place; what this movement was I shall presently undertake to estimate, and if iron ties were thought necessary then, there is no reason now for saying that they were inadvisable. Moreover, Grandclas would naturally have ascribed the entire widening, of which he was aware, to thrust, just as Mr. Bilson does now, and this must have influenced his action in inserting the iron ties.

VI.

We come now to the distorted vaulting ribs.‡ The fairest way to deal with these is to publish a telephoto (fig. 11), showing all the transverse ribs which exhibit distortions, and to point out that Mr. Bilson agrees with me in considering the distortion

* The entire page 410.

† Footnote, page 87, Rejoinder. Italics by W. H. G.

‡ "Cependant cette nef . . . ne s'est ni déformée ni déversée. La construction n'a subi aucune altération sensible." *Dict.*, II., page 333.

§ *Comptes Rendus, Académie des Inscriptions et Belles-Lettres, Bulletin d'Août*, pages 492–3. M. Choisy says of the enlargements, some of which he showed to the Academy: "Il serait souhaitable qu'une partie, au moins, de cette précieuse collection pût figurer parmi les documents dans nos musées."

* As a matter of fact I have considerably understated the amount of fissures which are called for by the accepted rates of inclination. The inclinations which are accepted for the height of the capitals, at the springing of the vaulting, continue to the tops of the clerestory windows (as they also do at Rheims). Thus the widening at the transverse joints of the wall cells is one third greater than it is at the level of the capitals. At this higher level the minimum widening is 16 inches, and the minimum width of a single fissure would therefore be about 8 inches, on the line of the transverse joint.

† Criticism, page 410.

‡ Diagram, page 89, Rejoinder.

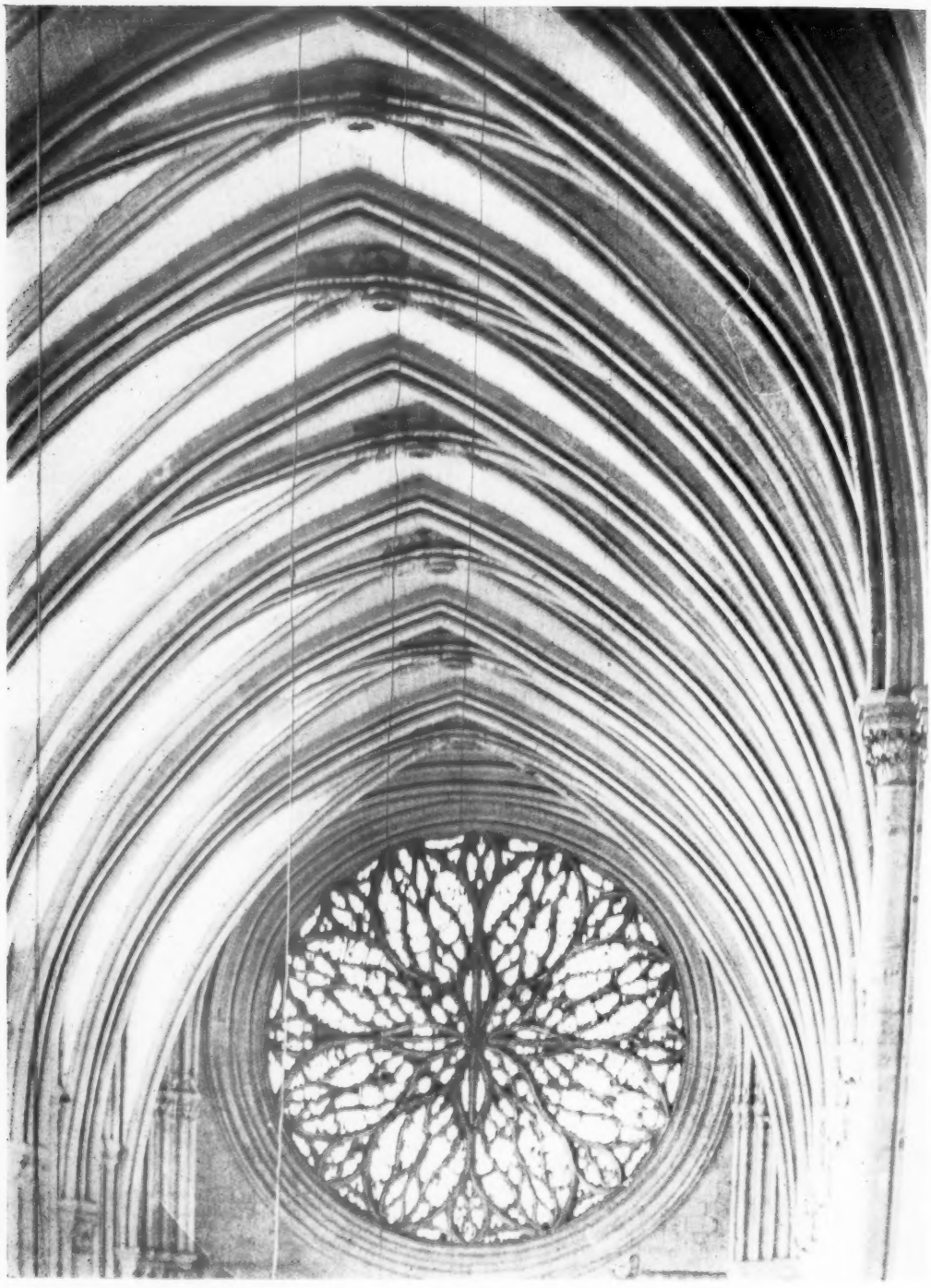

FIG. 11. TELEPHOTO OF THE NAVE VAULTING, TAKEN FROM THE CHOIR TRIFORIUM, SHOWING THE DISTORTED TRANSVERSE RIB 5, 6 (NEXT TO THE LAST ONE ON THE RIGHT), AND THE CONDITION OF OTHER TRANSVERSE RIBS. THE DEBATED TRANSVERSE RIB 13, 14, NORTH SIDE, IS IN THE FOREGROUND, NEXT THE CROSSING ARCH.

From a Brooklyn Museum enlargement, Series of 1907.

shown in the rib at the fifth bay of my numbering, (5, 6, fig. 1) as "the most marked." The Rejoinder announces minor distortions as follows: transverse; 9, 10, south half; 11, 12, north half; 13, 14, north half. All these ribs are well illustrated by the telephoto (compare fig. 1, Durand plan, for location). I do not agree that the north side of 13, 14 shows distortion and appeal to the telephoto. The diagonal ribs mentioned as distorted are 1, 4; 7, 10; 9, 12; all north side. They do not show well in the telephoto, and we will return to the transverse 5, 6, as being the "most marked" distortion, by mutual consent.

We will now inquire what transverse ribs are not mentioned by Mr. Bilson as distorted. They are 3, 4; 7, 8; 15, 16; and 17, 18. The "accepted" widening at 3, 4, is 14 inches at the capitals; the "accepted" widening at 7, 8, is 15¼ inches at the capitals. It would therefore appear, on Mr. Bilson's own showing, *that widenings of* 14 *and* 15 *inches exist at Amiens which have not distorted the transverse ribs.* Moreover, Mr. Bilson "agrees" (page 89) to my position that, "if the vaulting arches have gone down they must have become distorted, and if they have been distorted, that distortion must be visible." Why then is it invisible in the transverse ribs 3, 4; 7, 8; 13, 14; 15, 16; 17, 18? Clearly, because they have not gone down. Therefore Mr. Bilson must suppose that the ribs have spread accidentally, 15 inches at 7, 8, without going down, which is nonsense.*

Since it appears that 15 inches widening has caused no distortion in transverse 7, 8, it would appear that we might allow the difference between 15 inches at 7, 8, and 19½ inches at 5, 6, for the widening due to thrust which caused the distortion at 5, 6. About this amount of allowance will appear later on, and from entirely different considerations, to be proper.

It is impossible to discuss the distortion of the transverse rib at 5, 6, without noting, as Mr. Bilson has also done, the excess of the northern widening at pier 5, which is 12 inches, as against 7½ on one side and 9½ on the other, neither of the corresponding transverse ribs showing distortion. This leads us to remember that 2 inches out of 12 represent a constructive stepping back in the upper

FIG. 12.—VAULTING-SHAFTS, NORTH SIDE, 5, 7, 9, 11, 13, AT THE LEVEL OF THE CLERESTORY WINDOW SILLS; SHOWING THE STEPPING BACK OF SHAFT 5, ON THE LEFT IN THE PHOTOGRAPH. TAKEN FROM THE HIGH GALLERY ABOVE THE ORGAN LOFT. ENLARGED IN HALF-TONE FROM A 5 BY 7 PRINT. BROOKLYN MUSEUM SERIES OF 1907.

member of the vaulting shaft (fig. 12). When these 2 inches are subtracted, it appears that the slope of the pier 5 is closely equal to that of piers 7, 9 and 11 on the same side (table at page 717).

There is no other instance of stepping back in any vaulting shaft at Amiens. It was evidently a constructive experiment, and it has occurred to me that the unequal and extra widening thus introduced may have weakened the transverse rib and caused the distortion above that pier.*

* The Rejoinder (page 89) hedges on the rib distortions to the effect that: "In many cases it is impossible to reach a position from which a good view could be obtained," but 7, 8 is between 5, 6 and 9, 10, and can be as easily seen as either of them. At all events it is well shown by the telephoto.

* In St. Jacques, at Rheims, there are three different methods of widening in as many bays, the piers corresponding by pairs. In one of these bays two successive sections of the vaulting shafts over the piers are perpendicular on both sides, and the widening is obtained by successive stepping back of perpendicular sections of

In the matter of the amount of settlement at the crown of the vaulting, which would result from accidental widening, Mr. Bilson has corrected my estimate in a manner which must be admitted to be correct in theory, supposing his premised facts to have happened as he supposes them to happen. I have estimated the lowering at the crown, in case of accidental divergence, to be one-half the divergence, or 10 inches for an accidental widening of 20 inches. Mr. Bilson points out,* in effect, that this estimate only considers what would happen if a Gothic vaulting had straight ribs, and that an antecedent flattening out and straightening of the curving ribs would considerably reduce this estimate. Undoubtedly this is true in theory. The evidence that any Gothic vaulting had carefully straightened out all its ribs, before it decided to lower at the crown, would be quite interesting and would certainly reduce my estimate. Mr. Bilson may know churches which illustrate this interesting stage of the arrested development of accidental "refinements," but I do not. However, I agree to his opinion (page 89) that "absence of settlement at the crown" . . . "must be decided by the condition of the ribs themselves," and will leave this branch of the subject with the reflection that transverse ribs 3, 4 ; 7, 8 ; 13, 14 ; 15, 16 ; 17, 18 ; prove that there has been no settlement at the crown in the nave at Amiens, as far as those ribs are concerned, and such settlement is called for in their case by the accepted widening measures, if thrust had produced them.

VII.

After disposing of Mr. Bilson's theories, I am naturally led to consider what his Rejoinder has to say about my own demonstration. This proves that the outward inclinations of the vaulting shafts at Amiens include the masonry of the spandrils of the arcades, that the inclinations uniformly begin at the same point, viz., just over the arcade capitals, and that these inclinations, at that point, are opposed to the aisle thrust toward the nave. The demonstration proves that the inclinations are not the result of aisle thrust, because the majority of the piers (and all on the north side) are perpendicular, and finally the demonstration appeals to the fact that the inclinations (which include the triforium arcades) are in straight lines up to the nave vaulting, whereas they would bend outward at or above the triforium, if thrust from the nave vaulting had produced them. Fig. 13 is intended to recall the points illustrated by various cuts of larger size in the original Reply.

The Rejoinder dismisses this demonstration with careful, and perhaps significant, brevity; with a slighting reference, with an incomprehensible

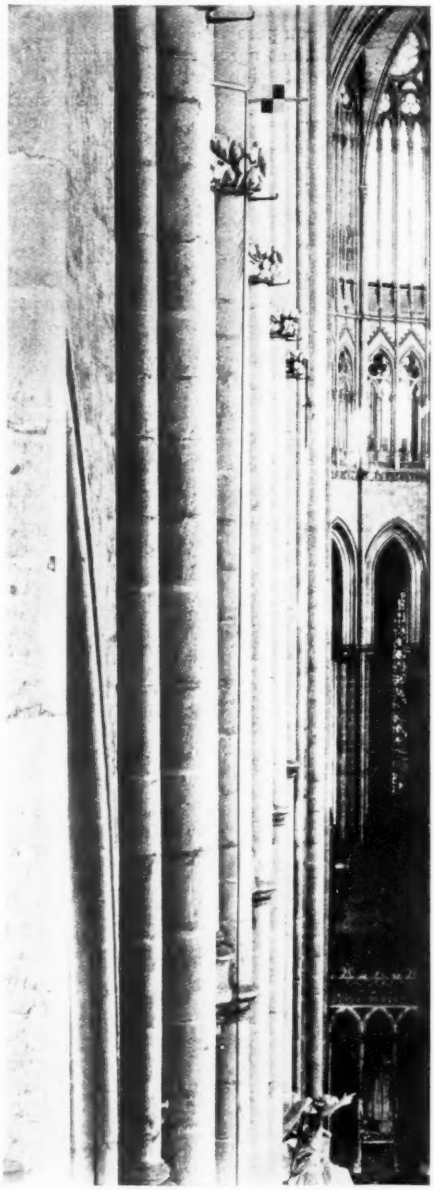

FIG. 13.—PLUMB AT PIER 7, NORTH SIDE, FOR THE VAULTING-SHAFT BETWEEN ARCADE CAPITAL AND TRIFORIUM STRING. 8 BY 10 DISC ON THE PLANE OF MEASUREMENT. RECESSION MEASURED AT 4 INCHES BY COMPASS TEST. ONE OF TWELVE SIMILAR DETAILS FOR THE PIERS OF THE NAVE. THE PIER BELOW IS PERPENDICULAR.
From a Brooklyn Museum enlargement, Series of 1907.

vaulting shaft. Experimental variations have other illustrations, as in Troyes Cathedral, where the eastern crossing piers change and diminish the pitch of the widening, about half-way up, thus forming slight elbows in the piers. The diminished pitch continues up to the vaulting. On the theory of thrust the pitch ought to increase, not diminish.

* Rejoinder, page 89, and footnote.

suggestion, and with a quibble about the straight lines.

The incomprehensible suggestion (page 87) relates to the point that the inclinations begin at the arcade capitals and against the aisle thrust. Mr. Bilson says: "This argument appears to me to be based on a misconception as to the direction of the thrusts, a misconception which might be removed by a study of Viollet-le-Duc's article on Construction," then referring to page 65 and fig. 34 of that article.

From some preceding portions of this Reply it would appear that Mr. Bilson's own studies of Viollet-le-Duc's article on Construction have been allowed to fall into abeyance. Nearly all the passages cited in this Paper from Viollet-le-Duc have been from that article, and it has appeared that Mr. Bilson has not entirely grasped their significance as related to causes of subsidence and dislocation. Under these circumstances I shall take the privilege of presuming that the "misconception" is Mr. Bilson's and not mine, and of proving this to be the case. Mr. Bilson may note, first, that there are two diagrams in Viollet-le-Duc's article on Construction which include the aisle thrust in their figured lines.* Both these diagrams show it as directed toward the nave. He will also find, in the passage relating to his quoted fig. 34, that, although the direction of aisle thrust toward the nave is not figured there, it is expressly mentioned as existing and as being neutralised by the nave thrust which is figured.

The aisle thrust is, of course, really in both directions, but is so absolutely held in check by the great exterior buttresses on the outer side that its active force is exerted toward the nave. It is the undisputed doctrine of Viollet-le-Duc that the aisle thrust toward the nave is neutralised by the loading which is ultimately placed on the piers, but that it still exists as a slumbering force, tending to maintain the equilibrium of the piers, as against the reverse action of the nave thrust at a greater height. To quote the words of Viollet-le-Duc in another connection, but directly applicable here: "The thrust is neutralised, but it exists. It is overpowered, but not suppressed."

If the pier be too slender for its task, if the loading above be insufficient, if the resistance of the flying buttresses be too weak, then there are two forces working in opposite directions, which in frequent theory, and doubtless in occasional fact, produce an accidental bend or curve in the pier and vaulting shaft; toward the nave below, and away from it above. So universally are these points recognised that perhaps there is not a sceptic in the world as to the widening refinement who is not positive that these opposing forces of lower aisle thrust and higher nave thrust have produced the supposed "refinement."

Now if I produce, for example, a series of enlargements, each with its own special plumb-line, proving that every pier on the north side at Amiens is perpendicular up to the capital, then I have proven that the bend at Amiens is not caused by aisle thrust, because in the latter case the piers would lean into the nave. Then if I prove, by another series of enlargements, also with individual plumb-lines in each special case—and confined to the section of the vaulting shaft which lies between the arcade capital and the triforium string—that the slope includes the masonry of the arcades and spandrils, that it begins at the arcade capital in every instance, and that it is uniform, within narrow variations,* on each given side of the nave for the whole side, then I have proven, in view of the uniform direction in straight lines of the inclination up to the vaulting of the nave, that the thrust of this vaulting did not cause the inclination. It is obvious that the resistance to the thrust of the nave vaulting increases in the descending line, and it is obvious that the resistance becomes practically impregnable below the triforium string, not only because the enormous weight of the aisle vaultings and arcade masonry is added to the resistance of the exterior buttresses, but also because the aisle thrust toward the nave, although neutralised in equilibrium, is still a force, "overpowered but not suppressed." So much stress does Viollet-le-Duc lay on the aisle thrust as counteracting through the loaded piers the nave thrust above, that he holds that the flying buttresses are only needed to hold up the nave vaulting in case the equilibrium between aisle thrust and nave thrust be disturbed.†

Since the resistance to the thrust of the nave vaulting increases in the descending line, and since that resistance becomes practically impregnable below the triforium, it results that the vertical lines would bend outward above, more than they do below, even admitting that the inclination below the triforium string down to the arcade capitals had been caused by the nave vaulting thrust.

There are thus two positions involved in one in this contention. One position is that under no circumstances could we suppose at Amiens that the aisle vaultings, arcade masonry, and spandrils could either be compressed or pushed over bodily, so as to result in a practically uniform outward slope, along both sides, reaching from the capitals of the piers to the triforium string. The other position is, admitting for the sake of argument that the nave vaulting had thrust in the manner described, that it certainly would not thrust in straight lines.

When I visited Rheims in July 1907, it was not necessary even to argue these points. It was only necessary to ask MM. Margotin and Martin to sight the piers as perpendicular, by the lamp wires, to verify the existence of the slope in straight lines, as beginning against aisle thrust at the arcade capitals, and to look up at the weight of the nave

* *Dict.* IV., page 56, fig. 32; page 74, fig. 40 *bis*.

* North side, $3\frac{1}{8}$, $3\frac{3}{4}$, 4, 4, $3\frac{1}{3}$, $3\frac{1}{2}$; south side, $2\frac{3}{4}$, $2\frac{1}{2}$, $2\frac{2}{3}$, $2\frac{1}{2}$, $2\frac{1}{2}$, 2 (measures from west to east).

† Passage already quoted in footnote; see page 729.

arcades and aisle vaulting. When the enlargements were shown to the architect-inspector at Amiens we did not even walk out from the Sacristy into the Amiens nave. Neither at Rheims nor at Amiens were the measurements for widening held to be a feature of the problem by the *Inspecteurs des Travaux*. The points considered were simply the slope, the point where it began, the resistance and weight at that point, and the absence of outward bend higher up. Of all the experts who have examined the new enlargements not one has contested the positions announced, and many experts have conceded them in the most outspoken and vigorous way.

Now comes Mr. Bilson, fresh from his new study of Amiens Cathedral, to say, as to the inclinations below the triforium, that he thinks there is a "misconception as to the direction of the thrusts" which might be removed by a study of fig. 34 of Viollet-le-Duc's article on Construction, and as to the straight lines: "I am not certain that Mr. Goodyear is correct in thinking that the divergences are in perfectly straight lines from the arcade capitals upward, for a comparison of his table* with his plumbings in the triforium passage shows that the inclinations are not precisely the same."

We will now test Mr. Bilson's statement that the inclinations are not precisely the same in the triforium passage and in the vaulting shafts lower down. The heights both of the triforium passage and of the vaulting shafts, from arcade capitals to string, are closely equal, being each about 24 feet. The measurements for these sections are as follows, from west to east:

North Side.

Triforium †	$3\frac{3}{8}$, $4\frac{3}{4}$, $4\frac{1}{2}$, 4, $3\frac{7}{8}$, 3
Shaft from arcade capital to string	$3\frac{1}{8}$, $3\frac{3}{4}$, 4, 4, $3\frac{3}{4}$, $3\frac{1}{2}$

South Side.

Triforium †	$2\frac{1}{2}$, $3\frac{1}{4}$, $2\frac{1}{2}$, $2\frac{1}{2}$, $2\frac{1}{4}$, 2
Shaft from arcade capital to string	$2\frac{3}{4}$, $2\frac{1}{2}$, $2\frac{7}{8}$, $2\frac{1}{2}$, $2\frac{1}{2}$, 2

Now what is the result of this comparison? It is that the fifth shaft, north side (5, Durand plan), is out of the straight line *one inch in* 48 *feet*. That is the maximum deviation from a straight line on the north side for a height of 48 feet. The corresponding pier, south side (6, Durand plan), is out of the straight line $\frac{3}{4}$ *of an inch in* 48 *feet*, and that is the maximum deviation on the south side for a height of 48 feet. Mr. Bilson certainly dies hard.‡‡

VIII.

What allowance should be made for accidental movement at Amiens? The uniform excess of the divergences on the north side would suggest, at first thought, that all the excess on that side should be allowed for accident; but when we consider that the excess uniformly begins at the arcade capitals, below the triforium, and is uniformly found there, in comparing the corresponding measures for the north and south sides, then it seems necessary to admit that, for some cause or other, the Cathedral was built as we now find it in this particular.

If it could be supposed that one entire side of the nave, up to the triforium, was built before the other, the difficulty would be solved. Then it would appear that the builders had determined either to increase or diminish the divergence after one side was finished.* The known general practice of cathedral building appears to forbid this solution of the difficulty, but there is one curious indication in its favour. All the vaulting shafts on the north side step forward an inch at the arcade capitals, whereas on the south side only the sixth pier (4, Durand plan) does this.† How can we imagine, if the usual method of construction by parallel bays was followed, that six vaulting shafts on the north side were stepped forward and that five on the south side were built flush with the piers? This seems incredible on the theory of parallel construction. However, if the usual habit of construction was followed, we have one difficulty to offset against another, and the uniform excess of slope on the north side has an undisputed parallel coincidence of variation, in the stepping forward of the vaulting shafts on the same side.

The fact that all the piers on the north side are perpendicular, up to the arcade capitals, discards the suggestion that the excess of slope below the triforium on that side is due to leaning piers.‡‡ If we now adopt the probable supposition that thrust has caused the minor outward deflections which are shown, by the plumbs in the triforium, to be in excess of the rate of inclination below the triforium for the same side and the same vaulting shaft, these deflections can be estimated by calculating the entire inclination at the rate found below the

* Page 45, Reply (page 717 of this Paper).

† The original plumbs in the triforium, with line of 15 feet, from which the measurements are figured for a height of 24 feet, are as follows (from west to east):—North side (foot decimals), 0·20, 0·25, 0·22, 0·22, 0·20, 0·15; south side (foot decimals), 0·13, 0·17, 0·13, 0·13, 0·12, 0·10.

‡ I will immediately add that I am disposed to attribute these deflections to thrust, together with all other slighter deflections in which the plumb in the triforium gives a larger result than appears below the triforium for the same height.

* See instance of change of slope at Troyes, footnote, page 734 of this Paper.

† See page 47, first Reply, and page 727 of this Paper, footnote *.

‡‡ The two piers next the crossing on the south side are perpendicular; the others lean slightly, as shown by figures in the table. Mr. Bilson makes the benevolent suggestion regarding these (page 87): "I suppose that he still contends that this slight lean is intentional." This rather superfluous irony shows a remarkable oblivion to the bearing of the argument just rehearsed. It is the demonstration that eight piers out of twelve, including all on one side, are perpendicular, which makes it certain that the inclinations of the vaulting shafts below the triforium are not due to aisle thrust. Why then should I weaken this argument by contending that four piers *lean into the nave by intention!*

triforium, and attributing the ascertained excess of actual measurement to thrust.

The following table is obtained by figuring the height of the vaulting shaft between arcade capital and triforium string (both members excluded) as 24 feet,* and by figuring the whole height of the vaulting shaft, without including capitals, at 60 feet.† Thus each photographic measure for inclination below the triforium represents $\frac{24}{60}$ or $\frac{2}{5}$ of the height of the vaulting shaft, and the inclination at the same rate for 60 feet is obtained by dividing by 2 and multiplying by 5. Thus we obtain the following :

TABLE OF ALLOWANCE FOR THRUST.

North Side.

	Inclination called for by rate below the triforium, as reckoned for entire height.	Combination estimates previously published, increased by 1 inch.‡	Tentative Estimate for thrust.
First pier	(13)... $8\frac{2}{4}$	8	0
Second pier	(11)... $9\frac{1}{4}$	$9\frac{1}{2}$	$\frac{1}{4}$
Third pier	(9)...10	$9\frac{7}{8}$	0
Fourth pier	(7)...10	$10\frac{1}{2}$	$\frac{5}{8}$
Fifth pier	(5)... $9\frac{1}{2}$	11§	$1\frac{3}{4}$
Sixth pier	(3)... $7\frac{3}{4}$	$8\frac{1}{2}$	$\frac{3}{4}$

South Side.

	Inclinations called for by rate below the triforium, as reckoned for entire height.	Inclinations as previously estimated and published.	Tentative Estimate for thrust.
First pier	(14)... 5	5	0
Second pier	(12)... $6\frac{1}{4}$	$6\frac{1}{4}$	0
Third pier	(10)... $6\frac{1}{4}$ ‖	$6\frac{1}{2}$–6 ¶	0
Fourth pier	(8)... $6\frac{2}{3}$ **	$6\frac{7}{12}$–$6\frac{1}{2}$ ††	0
Fifth pier	(6)... $6\frac{1}{4}$	$7\frac{1}{2}$–$6\frac{1}{2}$	$1\frac{1}{4}$
Sixth pier	(4)... $6\frac{1}{8}$	$6\frac{1}{2}$	0

TENTATIVE ESTIMATES FOR TOTAL WIDENINGS DUE TO THRUST.

11, 12	$\frac{1}{4}$ inch.
7, 8	$\frac{1}{2}$ "
5, 6	3 "
3, 4	$\frac{3}{4}$ "

The allowance for maximum accidental widening at 5, 6, of 3 inches appears to be as much as is called for by the recorded and obvious dilapidations.

It also appears to be as much as Mr. Bilson and M. Durand once thought necessary, for it has been twice pointed out that these dilapidations were all known to these gentlemen and had been carefully described by them when they considered the extreme widening in the nave "not appreciable to the eye . . . certainly not greater and most probably much less" than they thought it to be at the crossing, and when they thought $3\frac{1}{2}$ inches to be a correct estimate for the inclination of the south-west crossing pier.

Let us now examine the Rejoinder statement (page 90) that "no serious explanation has been vouchsafed to account for the irregularity of the backward leans at Amiens, if they are to be considered as due to intention ; why the western piers are perpendicular, while the divergence reaches its maximum two bays from the west end and gradually decreases towards the crossing."

As far as the inclinations themselves are concerned, the computations based on the rate of slant below the triforium string thoroughly dispose of any objections based on "irregularity of the backward leans." The uniformity for each given side is quite remarkable, especially when it is considered that diminishing measures near the crossing and near the tower piers are also found at Rheims (where the tower piers diverge about 4 inches to a side), and are naturally to be expected at Amiens, as avoiding abrupt contrast with the tower piers and with the diminished divergence at the crossing. The diminished divergence at the Amiens crossing may be explained from the point of view which may also be suggested for the Rheims crossing, where the piers appear to be perpendicular. The Rheims crossing piers were notoriously intended to support a very lofty spire, while the crossing spire at Amiens had no such unusual projected dimensions, but was still a loading on the piers which had to be considered. As to the tower piers at Amiens they are much more slender than those at Rheims, and it was probably considered unwise to diverge them on account of the proposed but unexecuted spires. As long as Mr. Bilson does not understand why the widening refinement existed at all, it may be best for him not to try to determine how this refinement ought to have been carried out in its minor details. At all events the explanation offered in my Reply (page 35) for the perpendicular tower piers, and here in part repeated, is undoubtedly a "serious explanation," in spite of the Rejoinder statement that "no serious explanation has been vouchsafed," and the allowance just made for thrust disposes of any other objection based on irregularity of the backward leans.

In the quotation just considered the statement is made that the "divergence reaches its maximum two bays from the west end." When the inclinations are calculated from the known rate below the triforium, and when these inclinations are assumed to be those originally constructed, the maximum is reached in the centre measures on the

* Actually 23 feet 11 inches.

† Actually 61 feet.

‡ With addition of 1 inch to each combination estimate, because 1 inch was subtracted for stepping forward at the arcade caps, north side (page 727). When inclinations are compared we must begin at the same face, which is the face above the cap.

§ The 2 inches added to combination estimate for stepping back of upper vaulting shaft cannot be figured when inclinations only are compared.

‖ Revised compass test on pier 10 gives $2\frac{1}{2}$ inches instead of 3.

¶ Revision above reduces 7 to $6\frac{1}{2}$ inches.

** Revised compass test on pier 8 gives $2\frac{2}{3}$ inches instead of 2.

†† Revision above increases $5\frac{7}{8}$ to $6\frac{7}{12}$ inches. The revisions for total combination estimates on piers 10 and 8 do not exceed the individual estimates already given for the same piers, here repeated. Therefore these revisions cannot be objected to. Although the revisions do not affect the widening estimates, they reduce the irregularities of inclination on the south side, as regards the combination estimates, and it was the existence of these irregularities as regards a diminishing measure at 8 which led me to retest the compass estimate.

north side, where it also appears at Rheims, and the centre measures on the south side also approach or reach the maximum, although they are so closely uniform with the other measures that the variations are not worth discussing.

Thus the Rejoinder argument (page 87) that the "pronounced irregularity of divergence is in itself a strong argument against intentional design" falls to pieces when tested and examined.

Mr. Bilson's ground plan for the tower piers at Amiens (fig. 7 of his Criticism) was supposed to explain, by showing the extra strength of abutment, why the tower piers do not lean at Amiens. It now appears that the corresponding tower piers at Rheims diverge 4 inches to a side, although both the piers and the abutments are much stronger than they are at Amiens. Therefore the strength of the tower abutments at Amiens cannot be the reason why the tower piers at Amiens do not widen, although this reason is advanced by Mr. Bilson with confident assurance.

IX.

The discussion of an allowance for thrust has necessarily preceded a consideration of the Rejoinder's matter on the buttresses. The movements represented by the allowances just made for thrust must have affected the buttresses, but that part of the Rejoinder which relates to them (page 88) is so wholly void of estimates or measures, and so utterly vague in purport and substance, that it may be dismissed without shrift. First, as to recent repairs of the buttresses, which are quoted by the Rejoinder as being indicated by recent dates carved upon them (from the 'forties of the nineteenth century) or as instanced for the repairs of 1895–6. Is it not clear that such recent repairs have no bearing on the controversy? They have no bearing, because there would be no controversy if such repairs had any relation to the recently accepted, but previously unknown, measures for the widening. If, for instance, damages had been repaired on the buttress 3*a*, *b* (mentioned by the Rejoinder, page 88) during the nineteenth century, and if these damages represented 7½ inches movement from thrust, everyone would already have known what has actually only been learned from the recently accepted measurements. All appeals to recent repairs are, on the face of things, inadequate to account for facts known now which were not known when those repairs were made.

On the other hand, when the question of ancient buttress repairs is examined, the records are found to be vague and indefinite, for it is certain that M. Durand's book has given all the information obtainable from them. The higher main buttresses above the aisle roofs, the pinnacles and the flying buttresses, have been more exposed to decay and disintegration from weathering than any other parts of the building, and unusually early and extensive repairs of these parts of Amiens Cathedral are to be taken for granted. The presumption that repairs to a buttress necessarily imply vaulting thrust, and that they could not have been called for by weathering, is the absurd premise of Mr. Bilson's consequently absurd list of buttress repairs. His only even approximately pertinent remarks on this subject relate to the flying buttresses. But when he speaks of joints which have been "pointed up" in flying buttresses, it is evident that no such repair would be of even momentary service if the flying buttress had lifted upward. If it did not lift upward the matter would not be worth talking about; it would then be an ordinary mason's repair of defective masonry. The allowances made for thrust show, however, that repairs for damage caused by thrust may have been called for in 11*a*, *b*; 7*a*, *b*; 5*a*, *b*; 3*a*, *b*, and 6*a*, *b*. The flying buttress 3*a*, *b*, is the only one specifically mentioned by the Rejoinder.

Of course the Rejoinder does not tell us how the repairs already known will account for the recently accepted widenings which have not been known; and this is all we really want to know.

X.

The Rejoinder concludes with the anticipatory warning that "it will not do to argue that part of the deflection may be due to intention and part to movement."

Somewhat aghast at such a veto on this apparently innocent proceeding we are led to inquire the reason and to give it all possible prominence. Mr. Bilson's reason is as follows: "At the east end of the nave, where the deflection is least, the cracks in the structure prove that the deflection is due to movement." * Mr. Bilson's closing appeal is thus to the cracks "at the east end of the nave," and is thus, presumably, to those described and illustrated in his first Criticism,† aside from the transept cracks illustrated by the opening figure of his Rejoinder and already debated in this Reply. Some brief notice of Mr. Bilson's argument about the vaulting at the crossing and of his related diagram and photograph will be found in a footnote at p. 720. Fig. 14 repeats the plan of the crossing vault, from fig. 4 of the original Criticism, and illustrates this footnote.

In its final remarks (page 90) the Rejoinder also refuses to believe "that the builders of the great French cathedrals ever built their piers with a backward lean in the direction of the thrust—a procedure directly opposed to the principles which

* Does this possibly relate to cracks at the east end of the nave, otherwise not mentioned by Mr. Bilson and here not specified by him, viz. those catalogued by M. Durand at 13, 15; 14, 16 (*Monographie*, I. 61)? If so, the matter would be covered by the unequal and greater subsidence of the crossing piers, as already discussed for the transepts. It is to be presumed, however, that the reference is to the crossing itself, to the cracks in the ceiling of its vaulting, and possibly to the transept cracks.

† Pages 409, 410, 411, 414; figs. 4, 5.

controlled their structural design, where all their efforts were concentrated on the problem of successfully counteracting thrust." This passage seems to suggest that the equilibrium of the Cathedral of Amiens would be disturbed if piers of 7 feet diameter were sloped 1 foot or less.* It is apparent that the centre of gravity of the pier would not be affected by such a slope, and that the equilibrium of the building would consequently not be affected by it.

It only remains to consider M. Enlart's entry into this controversy, as represented by his letter published in the JOURNAL R.I.B.A. (21st December 1907). This letter expresses the opinion that the "known history" of the Cathedral of Amiens con-

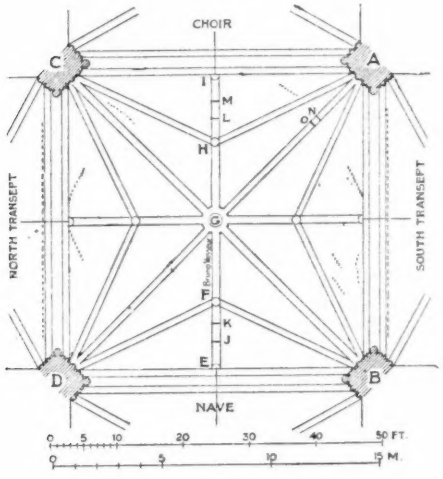

FIG. 14.—PLAN OF VAULT OF CROSSING.

tradicts my conclusions, "supposing even that an examination of the building does not." †

To this opinion I offer the following objections: The history of this Cathedral has been faithfully recited by M. Durand, and this recital has been faithfully republished by Mr. Bilson, in all points supposed to bear on this controversy. The history of the dilapidations of the Cathedral has not been enlarged or supplemented in any material manner during this controversy. When the controversy opened, the history of these dilapidations was supposed to explain an accidental widening in the nave which was held to be "certainly not greater, and most probably much less" than would be called for by an under-estimate for the south-western crossing pier, which figured its recession at 3½ inches. How can it be, therefore, that this "known history" of the Cathedral explains a maximum widening in the nave of nearly six times that amount, which is now admitted to exist and which was previously unknown to anyone? By this appeal to the "known history" of the church, M. Enlart has placed himself in the same dilemma in which Mr. Bilson and M. Durand find themselves.

If I have several times alluded to this dilemma, it is not to ridicule or criticise Mr. Bilson or his friends for not having perceived this widening. They have only shared the ignorance of their century. The optical effects of convergence in perspective have concealed the true widening from most eyes, and it is quite possible that one main purpose of the widening was to counteract this perspective convergence. The dilemma is, however, a serious one, because it is not likely that M. Durand's excellent history can be improved, unless this history were to include the refinement which M. Enlart refuses to admit as existing.

Thus M. Enlart, like Mr. Bilson in the concluding paragraph of his Criticism, p. 417, has staked his argument on the thesis that M. Durand's book supplies all the evidence needed to disprove the existence of a widening refinement at Amiens. The Reply which I now conclude meets and disputes this thesis, step by step. The arguments based on M. Durand's book have proved to be flimsy and shallow, and often inept and wholly irrelevant. It is quite natural that they should be infirm, for the book was written in ignorance of the true widening in the nave, and consequently in ignorance of the remarkable manner in which it is constructed.

Thus my reply to Mr. Bilson's Rejoinder also furnishes a very sufficient answer to M. Enlart's reference to the "known history" of the church.

As for M. Enlart's suggestion that a simple examination of the building, without reference to its history, is sufficient to contradict my conclusions, it betrays a touching confidence in the unassisted human eye which this research may ultimately tend to materially weaken in the opinion of the expert world in general, if not in that of M. Enlart. I submit that this examination cannot be carried out at Amiens by the eye, unassisted by plumb-lines, and that Amiens does not possess the natural advantages which are offered, in this particular, by the nave at Rheims.

It is therefore desirable, at present, that an expert who undertakes to pass an opinion on the given question for Amiens Cathedral should be familiar with the building *as it has recently been photographed*, and that he should not reject, or *at least not without examination*, the evidence which these photographs have furnished.

Note.—At present the Amiens transepts are represented by twenty-four new enlargements revealing unpublished facts of the most extraordinary significance for the general argument, but it is naturally impossible, for lack of space, to discuss or illustrate them in this Paper. As for the responds of the aisles, including those of the choir, they

* The measure of 7 feet diameter does not include the base or the base mouldings.

† "En aucun cas je ne saurais admettre la manière de voir de mon ami M. Goodyear au sujet de l'église de Saint-Quentin et de la Cathédrale d'Amiens, dont l'histoire est connue, et contredirait ses conclusions, à supposer que l'examen seul de ces édifices n'y suffise pas."

are now known to resemble those of Rheims Cathedral, as published by me in the *Revue de l'Art Chrétien* for July 1908. I formerly announced (page 124, Edinburgh Catalogue) that three out of fourteen responds in the aisles of the nave had no inclination, and Mr. Bilson argued, in consequence, that vaulting thrust had produced the other eleven recessions (page 416, Criticism). Improved methods of observation have proved that the supposed exceptions do not exist. The uniform and delicate inclination of the aisle responds is one of the most remarkable facts at Amiens, and of special interest as establishing a parallel with so many other churches in which the same aisle system is found, and where the integrity of the foundations may not be so widely notorious.

Mr. Bilson, to whom an advance proof of the foregoing Paper had been sent, replies :—

AMIENS CATHEDRAL.

There are many things in Mr. Goodyear's article to which I should be tempted to reply at length were I not convinced that no useful purpose would be served by prolonging this discussion indefinitely. I propose only to make a few remarks bearing on the essential points at issue between us.

If I understand Mr. Goodyear correctly, he admits that whatever buckling there is in the piers of the crossing is accidental, and that the slight inward lean of some of the arcade piers on the south side of the nave is also accidental. With regard to the outward divergence of the piers of the nave and crossing, from the level of the capitals of the arcade piers up to the level of the capitals of the vaulting shafts—a height of 61 feet—Mr. Goodyear's figures are as follows: north side, 5 inches at the crossing, increasing to 11 inches at pier 5, decreasing to 8½ inches at pier 3, and to nil at the western pier (1) which is vertical; south side, 5 inches at the crossing, increasing to 6½-7½ inches at pier 6, 6½ inches at pier 4, and nil at the western pier (2) which is vertical. He then makes some small deductions for divergence due to thrust, and he thus arrives at the net divergence which he believes to be intentional, varying from 5 to 10 inches on the north side, and from 5 to about 6½ inches on the south side [see table, p. 737 *ante*]. Except as regards the crossing piers, Mr. Goodyear has not yet offered any explanation of the irregularity of these divergences, if they are to be considered as due to intention. This irregularity is perfectly intelligible if, as I hold is proved by the condition of the structure, the whole divergence is due to accidental movement, and the pronounced indications of movement in the western bays can only be connected with the quick return to the vertical at the western piers 1 and 2 from a divergence of 11 inches on the north side and some 7 inches on the south side, at a distance of two bays further east. Mr. Goodyear, however, attributes these indications chiefly to settlement, resulting from compression of the mortar beds. That some movement has occurred which is due to this cause is undeniable, but it is quite insufficient to account for the visible indications of lateral movement. Mr. Goodyear's statement in this connection [*ante*, p. 724], that the piers 3 and 4 have settled more than the piers 1 and 2, is proved to be incorrect by the levels of and cracks in the parapet of the triforium of the western bay. On the south side, at the crack in bay 2, 4, the top of the stone to the west of the crack is ¾ inch below the top of the stone to the east of it, and the level of the top of the parapet at the east end of this bay is 1¼ inch above that at the west end. On the north side, in the bay 1, 3, the level of the top of the parapet at the east end of this bay is 3 inches above that at the west end. These facts prove that the western piers 1 and 2 have settled more than the piers 3 and 4, and not the contrary as Mr. Goodyear asserts.

Mr. Goodyear's argument in favour of intention for these divergences really amounts to this: that if they were accidental, the evidence afforded by the present condition of the structure would be quite different from what it actually is; that if, for instance, there is a difference of divergence of 3 inches in two adjoining vaulting-shafts, *transverse* fractures amounting to 3 inches should be visible. His ideas on this point may safely be left to the judgment of those who have studied the effects of movement in similar structures, and they are emphatically contradicted by what has actually happened in cases where such divergences are incontestably due to accidental movement alone. At the Avallon meeting of the *Société française d'archéologie* in 1907, M. Lefèvre-Pontalis called attention to instances in Burgundian churches where the thrust of the vaults was not (originally at any rate) abutted by flying buttresses. I have already mentioned two cases,* and that of the eastern aisle of the south transept of Beverley Minster (*c.* 1240) is very much to the point. Here the bays are about 16 feet in width, and the divergence of the wall from the vertical at successive vaulting-shafts, ascertained by actual plumbings, is ¼ inch, 8¾ inches, 7½ inches, and 4½ inches in a height of 21 feet. The divergences are consequently of greater comparative extent than those at Amiens, but the indications of movement in the structure are precisely analogous to those visible in the nave of Amiens, and not in the least like what Mr. Goodyear's ideas would involve.

Mr. Goodyear considers that he has proved that the divergences from the vertical at Amiens are for the most part due to intention. I hold that the condition of the structure proves that they are due to accidental movement only. The facts have been set fully before our readers, who are in a position to form their own conclusions upon them.

JOHN BILSON.

* JOURNAL R.I.B.A., 3rd Ser., XIII., 404, note ‡.

THE LATE M. AUGUSTE CHOISY

[Hon. Corr. M.].

It is with very sincere regret that we have to record the sudden death, at the age of sixty-eight, of M. Auguste Choisy, the distinguished architectural historian to whom the Royal Gold Medal was accorded by the Institute in 1904. M. Choisy was the son of an architect at Vitry-le-François (Marne), where he was born on 17th February 1841, and his early interest in our craft was probably derived from his father. The statement, however, which he made on the occasion of the presentation of the Gold Medal, to the effect that when quite a youth and looking through his father's library he came across a copy of the TRANSACTIONS of the Institute of 1842 in which he read Professor Willis's Paper on the Vaults of the Middle Ages, constitutes a memorable incident in the annals of our Institute. As M. Choisy said, the Paper was a revelation to him, in that it showed how forms ought to be analysed, and how drawings ought to show clearly the structure. When he commenced his studies of the Roman methods of building Professor Willis's disquisition was ever present to him as the best model to be followed, distinguishing at once the commencement and the conclusion of architectural criticism.

M. Choisy's studies were commenced in the École Polytechnique, where he had the advantage of following the lectures given by the eminent professor, M. Léonce Reynaud, whose *Traité d'Architecture*, in two folio volumes, illustrated with fine engravings, still forms the standard work of reference in all the French schools. His career in the École Polytechnique enabled M. Choisy to enter, in 1863, the "École des Ponts et Chaussées," an institution of which we have no parallel in England. In the following seven years he would seem to have been able to travel in various parts of Europe, and it was during this period that he conceived the idea of making a minute analysis of Roman construction. I met him as a stranger in Athens in August of 1866 when measuring the plan of the theatre of Bacchus, and was astonished at the exceptional knowledge he seemed to possess of the buildings of the Acropolis. Subsequently I was introduced to him at the French School in Athens, and in my diary placed a record to that effect, and also that he had written many essays on archæological subjects which had received the approval of the Institute of France. His first important work, *L'Art de bâtir chez les Romains*, was not published before 1873, but already, in 1868 or 1869, he must have made some progress with it, because in M. Viollet-le-Duc's *Dictionnaire Raisonné*, under the article "Voûte," p. 477, vol. ix., is a note by the author stating that a young French engineer, M. Choisy, would publish shortly a very complete work on the structure of the Roman vaults, which had been lent him to read, and in which a detailed description would be given of the various methods employed by their great builders, demonstrating by the clearest arguments that economy in expense was one of their principal considerations. The publication of this work was apparently deferred on account of the Franco-German war, which paralysed everything in France. Its great importance, however, resulted in a recommendation, which was made by his former professor, M. Léonce Reynaud, and by M. Viollet-le-Duc, that he should be sent on a mission to the East to study the buildings of the Byzantine Empire, and in 1882 M. Choisy published his second great work, *L'Art de bâtir chez les Byzantins*. It was about this time that, on the recommendation of his friend and comrade M. Ferdinand de Dartein, Professor of Architectural History in the École Polytechnique, and author of the magnificent work of S. Ambrogio, Milan, he was brought into the educational section of that institution and was appointed "Professor adjoint." The courses of lectures which he delivered to the students would seem to have led to his third great work, viz. *L'Histoire de l'Architecture*, published in 1899. Within the compass of two octavo volumes M. Choisy has condensed that which might easily be expanded into twenty; but in the descriptions which he gives and the drawings with which the work is illustrated his object would seem to have been to use the fewest words and the least number of lines. All the drawings were made by him, a great number of them being in isometrical projection, the most difficult type of representation, and one which requires a profound mathematical knowledge. In 1883, shortly after his appointment as professor, M. Choisy published another work, which is less known, viz. *Études épigraphiques sur l'Architecture grecque*: these studies include a translation of the specification of the work still required to complete the Erechtheum, and also a translation of the specification of the Arsenal of the Piræus which was found in 1882 engraved on a slab of Hymettian marble. The description given was so clear that, although the building was destroyed in 86 B.C., M. Choisy was able to work out plans, sections, and elevations of the arsenal, and these are published in his work. In 1904 he published his last work, *L'Art de bâtir chez les Égyptiens*, which was reviewed in this JOURNAL in January of that year. It was in this year that M. Choisy retired from his work in the École des Ponts et Chaussées and the École Polytechnique, intending to devote the remainder of his life to a work on Vitruvius. When I saw him last, in August 1904, he said it would take at least a year and a half to make the drawings and annotate the descriptions given by Vitruvius. That is now five years ago, so that he had apparently found the task to be one of greater difficulty than he had anticipated. It is to be hoped, however, that sufficient progress has already been made with it to

warrant its publication, to which we should all look forward with the greatest possible interest. I have only two other tributes to record to his memory: the first is that his greatest work, *The History of Architecture*, has now become an authority constantly referred to in all works on similar subjects, not only in France, but in England, America, and Germany; and the second, that he was always ready at any time to answer communications made to him on various subjects; and his replies were always of the kindest description, for if he differed widely from the views of his correspondent he always managed in his answers to elude the differences and to encourage him in his researches.

R. Phenè Spiers, F.S.A. [*F.*].

DU CERCEAU AND DE L'ORME.

To the Editor Journal R.I.B.A.,—

Sir,—Several interesting problems are suggested by Mr. John W. Simpson in his most generous and sympathetic review of "French Châteaux and Gardens of the Sixteenth Century" in your issue of Aug. 28. In most cases no data, I fear, exist for a solution of them. But some slight ground may perhaps be found for an affirmative reply to his query, "Did Catharine de Médicis hand over the designs of De l'Orme to Du Cerceau after the former died in 1570?" in the fact that among Du Cerceau's published or unpublished works there are drawings referring to at least two other buildings on which De l'Orme was employed as architect by Catharine, and illustrating unexecuted or only partly executed designs of his, *i.e.* the châteaux of Chenonceaux and St. Maur-les-Fossés. Catharine, having acquired the former in exchange for Chaumont from her rival Diane de Poitiers after Henry II.'s death, intended, as Du Cerceau informs us, to extend it considerably. The plans for this extension are in the British Museum collection and are engraved in a reduced and slightly modified form in "Les Plus Excellents Bastiments de France." They include an elliptical hall at the further end of the bridge gallery; a stately court of honour before the château with a hemicycle on either side, each leading to what appears to be a sort of nymphæum; and a great fore-court, whose sides converge towards the castle. A fragment of one of these sides is the only part of this scheme in existence. As regards St. Maur its history is given in "French Châteaux," and I need not repeat it here.

It is curious, however, that Catharine should have handed over De l'Orme's drawings to Du Cerceau rather than to Jean Bullant, who succeeded the former as her architect, unless indeed she did so with the express object of their being utilised in the book he was preparing under her patronage. Why, then, did he not reproduce some of the most interesting of the designs after having gone to the trouble of making elaborate drawings from them? I can offer no answer to the question except it be to suggest that in the case of the Tuileries Catharine may not have relished seeing great prominence given to a noble scheme whose abandonment two years after De l'Orme's death was caused by her pusillanimous credulity.

Since there is no evidence that De l'Orme and Du Cerceau were on terms of friendship, though they can scarcely have failed to be acquainted, it is not likely that the former gave his drawings to the latter. But De l'Orme having no professional heirs his papers may have been sold to Du Cerceau; in that case, however, he might be expected to betray a knowledge of De l'Orme's works for his non-royal clients, such as the château of Meudon for the Cardinal of Lorraine. On the whole the theory that he got them from the Queen-Mother seems to fit the facts best.

Yours faithfully,

7th September 1909. W. H. Ward, M.A. [*A.*].

THE R.I.B.A. SCALE OF CHARGES.

To the Editor Journal R.I.B.A.,—

Sir,—In the issue of the Journal dated the 24th July 1909 Mr. Henry W. Burrows solicited information as to whether an architect could, under the Institute Scale of Charges, charge more than 5 per cent. where the works involved structural alterations and exceeded the sum of £1,000 in amount. I think Mr. Burrows might, as a good many other members of the Institute do, ask a good many questions concerning the Institute Scale of Charges, which require clearing up and rendering definite in a variety of particulars. Take, for instance, paragraph 3: "In all works of less cost than £1,000, &c., &c., 5 per cent. is not remunerative, and the architect's charge is regulated by special circumstances and conditions." Let it be assumed, therefore, that under such circumstances a charge of, say, 10 per cent. would be remunerative, how does such a charge work out in practice? A contract is entered into involving an outlay of, say, £950, and the architect would in due course charge the sum of £95 for his professional services rendered. But the client in course of the work orders an additional outlay of £100, making a total outlay of £1,050, whereupon, referring to the Institute Scale, the architect—who is always considered to be a person void of emotion—finds that 5 per cent. under such circumstances is remunerative, although he knows that it is not, and his charge in consequence will be reduced to the magnificent sum of £52 10*s*. So the absurd position arises that if he carries out work to the extent of £950, the amount originally intended, he will be paid the sum of £95, and if he supervises a further outlay of £100 he will receive the sum of £52 10*s*.—in other words, incur a loss of £42 10*s*. for his additional service. Then, again, under clause 3: "In all works of less cost than £1,000, and in cases of alterations and addi-

tions to buildings, 5 per cent. is not remunerative." Well, what is remunerative? Why not clear up the point? why leave the individual practitioner in the air, judge and jury in the air, and the client in the air, seeking *terra firma* also? This part of paragraph 3, "structural alterations and additions to old buildings," is most unsatisfactory. Then, again, paragraph 5: "If the architect should have drawn out the approved design, with plans, elevations, sections, and specification, the charge is 2½ per cent. upon the estimated cost. If he should have procured tenders in accordance with the instruction of his employer the charge is ½ per cent. in addition." Quite so; but suppose if in addition the architect has prepared the whole of the working drawings and details, what charge is he to make? The Institute Schedule is quite silent upon the point, but in Hurst's *Architectural Surveyor's Handbook* the charge for "working and detail drawings" is given at 1¼ per cent. I have a case occurring on this point at the present moment, and I must say that when one comes to justify one's position by the Institute Schedule you feel that unpleasant sensation of being left in the lurch.

Once more, the discrepancies in tendering have now become so great as to almost amount to robbing the architect of his remuneration. Just to look, for instance, at the following tenders received, omitting the odd figures: £3,600, £3,500, £3,100, £2,900, and £2,300. Nearly the whole of this work was structural alterations, involving considerable responsibility. I have had to lose one-third of fees in consequence of the discrepancy in the lowest tender by this reckless tendering, and being structural alterations in addition it involved a double loss. Here are another set of tenders received, the works not being proceeded with, all the details having been prepared of an elaborate character: £1,500, £1,450, and the lowest £1,150, involving again a loss of 25 per cent. to the architect and not a little disputation because the Institute Schedule is so indefinite.

I have also known cases where an architect, suing for his fees in the High Court, and the not unusual counterclaim of damages for professional negligence having been set up, found to his astonishment that four or five Fellows of the Institute put in an appearance on behalf of the defendants. Ultimately in the cases I have referred to the counterclaims for damages for negligence were withdrawn in writing: so what on earth were those architects, outside the somewhat sordid level of giving bread-and-butter evidence, going to oppose in Court? Apparently the Institute Schedule. Surely all members of the Institute should be called upon to support the Institute Schedule of Charges when it has been made sufficiently definite and clear upon all points to enable them to do so.

Building has been growing in complexity for some time past, and an architect is obliged to have more than one contractor to carry out the work, calling in the services of several sub-contractors, which means obtaining separate estimates, separate contracts, certificates, and sets of accounts, so that the old 5 per cent. charge for remuneration has for some time past ceased to be remunerative. I therefore suggest that the Institute Schedule should be amended and that for all new buildings and works the scale charge for the first £1,000 should be 10 per cent. for the first £500 and 7½ per cent. for the second, and for the second £1,000 and subsequently 6 per cent. throughout; that for all structural alterations and additions the charge should be uniformly 10 per cent.; and for all working drawings and details 1½ per cent., leaving the balance of the percentage for supervision. Apologising for troubling you at such length,

Yours faithfully,

Kensington: September 1909. A FELLOW.

CASTS AT THE BRITISH MUSEUM:

Sarcophagus of Alexander Severus.

To the Editor JOURNAL R.I.B.A.,—

SIR,—In reference to the quotation from *The Times*, on page 703 of the JOURNAL, throwing doubt on the connection between the Portland vase and the sarcophagus of Alexander Severus, is the writer aware that Piranesi, in Plate XXXV. of Vol. II. of the *Antichita Romane*, plainly shows the vase *in* the sarcophagus (Urna) and describes it as "*trovato colle ceneri dentro Urna*"? This is a good deal later than "the sixteenth century," and Chambers states that the vase was found *in* the sarcophagus between 1623 and 1644.

I am not well acquainted with the controversy, but understood that, while the identity of the sarcophagus with Alexander Severus was uncertain, there was no doubt about its connection with the vase.—Yours faithfully,

R. LANGTON COLE [*F.*].

REVIEWS.

CHEMISTRY OF BUILDING MATERIALS.

Introduction to the Chemistry and Physics of Building Materials. By Alan E. Munby, M.A.Cantab. 8o. Lond. 1909. 6*s. net.* [*Archibald Constable & Co., Ltd.*]

The aim of the volume is, according to the preface, "to enable anyone with no knowledge of natural science whatever to appreciate something of the chemical and physical principles which underlie the use of building materials. The first part of the book endeavours to explain the principles of chemistry, physics, and geology . . . directly applicable to the production, use, and decay of materials, while in the second part, which comprises more than two-thirds of the volume, these principles are applied to the study of stones, brick clays, limes and cements,

the metals, timber, and paint." It will be seen that the author covers a wide field in a small space, and it may be said at once that, whilst the whole of the book is pleasantly written in popular language, the value of different portions is very unequal. In the first or scientific part general principles are explained and units defined in a lucid and interesting manner, though perhaps it might have been more strongly emphasised that many of the statements are of necessity mere generalisations which cannot be applied to particular cases without qualification. On the other hand, unnecessary caution is sometimes shown, as in the statement that hydrogen is *almost* the lightest substance known. In the section on Heat no mention is made by name of the British thermal unit, largely used in this country. The value of the unit of time, or second, might have been referred to the length of a standard pendulum. The author is to be congratulated on his courage in coining the word "ferra" for ferric oxide, though it is doubtful whether this term will find general acceptance.

In the second or technical part is given a general description of the chief materials of construction and of the tests commonly applied. Stones, cements, and timber are well treated, but the sections on metallurgy, oils, and pigments are of less value. Thus the general outline of operations on p. 229 does not apply to copper or to many other metals. The winning of aluminium is not as simple as described, and there are other minor misstatements, *e.g.* as to the effect of antimony and phosphorus on copper. Boiled oil is a partially oxidised body, not an oil freed from its more volatile constituents; lac as such is not soluble in water, although it contains a soluble pigment. The use of galvanised iron should have been mentioned. The brief descriptions of analytical processes in these sections, as well as in that dealing with water, might have been omitted, and the space so gained devoted to a more detailed discussion of the meaning of analytical results supplied by experts.

The book is well printed and contains a good index. Few misprints have been noticed: site on p. 135, extention on p. 273, ductible on p. 265, chal(c)opyrite on p. 250, Hamp (e) on p. 254, and Bauerchinger both in the text and index.

A. G. Levy, B.Sc (Lond.), F.I.C.

VALUATIONS.

Valuation of Real Property: A Guide to the Principles of Valuation of Land and Buildings, &c., for various Purposes. By Clarence A. Webb, P.A.S.I. 8o. Lond. 1909. Price 7s. 6d. net. [*Crosby Lockwood & Son, 7 Stationers' Hall Court, E.C.*]

This book is, as its preface states, intended to convey a general knowledge of the principles and practice of the valuation of real property for various purposes, and to be used as a text-book by students. The ground covered is thus very wide, and, as the body of the book does not extend to 300 pages, and includes a good many examples of actual valuations given at full length, as well as some useful tables, compression has been unavoidable. From this cause, and perhaps also, to some extent, from the difficulty, so generally felt by an expert, as to how elementary he should make his earlier chapters, there is rather less explanation of first principles than to some may seem desirable in a book for beginners. On the other hand, it is probably safe to assume that this unattractive subject is only seriously taken up by the student after he has had considerable general experience and has picked up enough fragments of knowledge to be able to start at the point selected by the author.

In the chapter upon "Principles" will be found, among other things, notes upon valuations of agricultural and building land, ground and rack rents, houses and cottages, public-houses, &c., illustrated by cases given in detail. There are also tables showing the yield per cent. derived from investments in Consols and ground rents respectively at the actual average market prices for each year from 1892 to 1908.

In the chapter on "Value of Land and Buildings Separately" is repeated, without more comment than is supplied by the other figures in the table, the statement that the actual cost of a cottage with four rooms and scullery, built with 9-inch walls roughcast and whitewashed and with tiled roof, was, at Letchworth, in 1905, 3½*d.* per cube foot—£150 per cottage. To say the least, this is misleading to a beginner, as is the statement, on page 21, that the cost of a building "may generally be taken at ten times its rack rental." There should be some hint that even erections of the quality sometimes called "garden city building" can scarcely be put up at these figures now.

The chapter upon the Finance Bill 1909 will have its value reduced by the considerable alterations made in the Bill since the book went to press.

The ruling considerations in valuation for mortgage, compensation for compulsory purchase, and other purposes are clearly stated, and the book as a whole is a desirable addition to the list of text-books.

Matt. Garbutt [*F.*].

New Books.

Mr. Batsford's autumn announcements include:—

Windows, a Book about Stained and Painted Glass, by Lewis F. Day. (3rd edition.)

Nature and Ornament, by Lewis F. Day. Part II., dealing with Ornament, the finished product of Nature.

English Furniture and Decoration from 1680–1800, by G. M. Ellwood.

The Growth of the English House: a short History of its Architectural Development from 1100–1800, by J. Alfred Gotch, F.S.A.

English Leadwork: its Art and History, by Lawrence Weaver, F.S.A.

Modern Cabinet Work: Furniture and Fitments, by Percy A. Wells and J. Hooper.

9 CONDUIT STREET, LONDON, W., *25th September* 1909.

CHRONICLE.

Sessional Programme, 1909-10.

The following is the programme for the Institute Sessional Meetings 1909–10 :—

Nov. 1.—President's Opening Address; Presentation of the Royal Gold Medal to Dr. Arthur John Evans, F.R.S.; Address by Dr. Evans on Recent Discoveries in Crete.
Nov. 15.—"The Planning and Laying Out of Public Places." By H. Inigo Triggs [*A.*].
Nov. 29.—Business Meeting.
Dec. 13.—"Architectural Education in America." By A. D. F. Hamlin, A.M. (Columbia University).
Jan. 3, 1910.—Business Meeting.
Jan. 17.—"Carr of York." By S. D. Kitson, M.A. Cantab. [*F.*]. Award of Prizes and Studentships.
Jan. 31.—President's Address to Students; Presentation of Prizes.
Feb. 14.—"George Frederick Bodley." By Edward Warren, F.S.A. [*F.*].
Feb. 28.—Business Meeting: Election of Royal Gold Medallist.
Mar. 14.—"The Business Side of Architecture." By A. A. Hudson, Barrister-at-Law [*H.A.*].
Apr. 4.—"The Architecture of Adventure." By Professor W. R. Lethaby [*F.*].
Apr. 18.—"Architecture of the Balkan States." By George Hubbard, F.S.A. [*F.*].
May 2.—Annual General Meeting.
May 23.—Paper. (*Subject to be announced.*)
June 6.—Business Meeting: Annual Elections.
June 20.—Presentation of the Royal Gold Medal.

The School of Civic Design, University of Liverpool.

The School of Civic Design which has been established as a Department of the School of Architecture in the University of Liverpool has issued the Prospectus for its first Session, which opens on the 5th October. The Prospectus, uniform in all respects with that of the School of Architecture noticed in the last number of the JOURNAL, is embellished with illustrations in half-tone and colour-reproduced from some beautiful drawings by the Professor of the School, Mr. S. D. Adshead [*F.*]. The frontispiece presents a plan and perspective view showing the improvements to the British Museum main front designed by Mr. J. J. Burnet, A.R.S.A., together with the new approach from the north. The drawing includes also Professor Adshead's suggested improvement of the Museum approaches from the south. Here are shown St. George's Church preserved and the main axis of the Museum maintained by a new street 100 feet in width and axial with Waterloo Bridge. The junction of roads at the head of Shaftesbury Avenue, Holborn, and Hart Street is shown greatly improved. The other illustrations consist of a suggested and most desirable Marble Arch Improvement Scheme; a bird's-eye view, printed in colours, of a proposal for the laying-out of St. Michael's and Fulwood Park, Liverpool; and a plan for the treatment of some vacant land in the same neighbourhood.

Particulars of the courses of study open to students in the new School will be given in the forthcoming issue of the R.I.B.A. KALENDAR. Meanwhile some extracts from Professor Adshead's Introduction to the Prospectus may usefully be given here :—

Town Planning, although intimately connected with Architecture and Engineering, is a distinct and separate study in itself, and the primary object of the School is to equip Architects, Engineers, and others with a knowledge of the supplementary subjects which Town Planning connotes and to enable them to occupy with credit those advisory and permanent positions which must necessarily be created as legislation affecting civic development and extension becomes increasingly efficient.

The rapid growth of cities in the immediate past and the inadequacy of statutory powers to control their extension have resulted in overcrowding, street malformation, and general congestion. Large estates, situated on the confines of cities, have gradually been absorbed, cut up and sold in small plots, and this, accompanied as it has been by an increasing tendency on the part of the new ownerships towards individualistic expression, has produced æsthetic confusion and general disorder. During recent years there has been a universal awakening to the necessity for co-ordinate action between property owners and municipal authorities to remedy existing defects and to prevent further excesses; and, as a result, in Germany there now exists powerful statutory control over building areas. The municipal authorities in Germany have vested in them powers which enable them to exercise complete control over the direction of all new streets, parks, and public places; to limit the height of buildings, and to define the proportions that shall obtain between built-up areas and open spaces.

In this country we have at the present moment before Parliament a Bill empowering local authorities to control the laying-out of new streets and building areas. The procedure under this Act will be as follows :—

The Borough or Urban District Council or other local authority will in the first place be required to show the Local Government Board a *prima facie* case for making a building plan, or in certain cases the Local Government Board will instruct such body to make a plan; or, in the event of a satisfactory plan being made by a private party representing ownership, the Local Government Board may call upon the Local Authority to be responsible for the carrying-out of such plan. But whether the plan be made by a local authority or by a private party it is obvious that either must call in such professional assistance as may to them seem fit.

Referring to procedure in Germany we find that engaged in making the Town Plan there is, in the first place, the

municipal architect, specially trained for this work; and associated with him are the municipal engineer and statistician, an official who in many ways corresponds to our medical officer of health. There is no doubt that in the making of the Town Plan in this country a similar representation will act. It is the aim of the School to equip architects, engineers, and others with the qualifications required for such work.

Whilst a Town Plan may be laid out with well-directed and sufficiently spacious roadways, well-disposed parks and parkways, and well-distributed classes of buildings, it will entirely fail unless its masses and units are considered from the point of view of elevation as well as plan. In the realisation of a Town Plan it is the complete effect of the architecture rather than the mere plan that influences the citizen. Nor is it sufficient that the individual buildings excel in architectural merit; they must bear a well-considered relationship to one another. The Town Planning Bill and existing Parliamentary and Local Acts have very little practical bearing on this side of the question. Whilst there is danger in statutory control of elevation, both in view of the discouraging effect it might have on private enterprise, and also on account of the difficulties attending the expression of official opinion in matters relating to taste and style, still this in no way detracts from the importance of the fact that a co-ordination of parts is absolutely essential to complete success. The establishment of a Ministry of Fine Arts or other corporate body empowered to control the æsthetics of cities is an item in the legislative programme of the future which it is to be hoped will very shortly receive attention. In the meantime it behoves those of us who are entrusted with private undertakings and also those municipal officials and students who may occupy official positions, upon whom in their advisory capacity so much depends, to take up the definite study of Civic Design. It is necessary not only to master the practical difficulties involved in the making of the statutory Town Plan, but also to be able to apply those principles which directly control the æsthetic aspects of the city and its suburbs, fully realising their completed effect.

In the organisation of the School and in the training of students the courses will consist of lectures and studio work. The lecture courses will be arranged under the following heads:—Civic Development, Engineering, Law, Architecture, Decoration, Landscape Design. On the Staff as Instructors and Lecturers the School has been fortunate in obtaining the services of the present Lord Mayor of Liverpool, Mr. H. C. Dowdall, Barrister-at-Law; Professor Brodie, Municipal Engineer to the Corporation of Liverpool; Professor Hope, the Medical Officer of Health; and Mr. Thomas Mawson, Landscape Architect.

The School is intimately connected with the School of Architecture, of which it forms a Department, and the students of both Schools will pursue their studies together in the same studio. This arrangement will, it is anticipated, tend to exercise a beneficial influence on both. The system of teaching in the School of Architecture is based upon that of the Ecole des Beaux-Arts of Paris and the Architectural Schools of America;—a system which gives prominence to the study of monumental composition and of those larger problems in architecture which have hitherto been so much better understood on the Continent and in America, and which figure so prominently in the study of Civic Design. To illustrate fully a Town Planning scheme, it is necessary to produce not only an accurate plan, sections of contours and elevations, but also a bird's-eye view or continuous perspective; certainly such drawings are of invaluable assistance in explaining a scheme. In the studio these two methods of draughtsmanship will be fully demonstrated, both as regards method in setting up and also as regards rendering in monotone or colour. The teaching of draughtsmanship in its higher branches will form a very important part of the work done in the studio.

The work of the School will be carried on during the Autumn and Lent terms of the academic year, which period constitutes a Session of the Department; and in connection with the work of the School, the University has instituted a Certificate and a Diploma. The Certificate will be given to students who have done satisfactory work during two terms of the academic year, and the granting of the Certificate will largely depend upon knowledge acquired during attendance at the Lecture Courses. The Diploma will be granted to those students who, having worked in the studio during a second session, have fully drawn out town-planning incidents and schemes. Just as it is necessary for the Medical Officer of Health to obtain his diploma before taking an official position, so it is hoped that the possession of the Diploma in Civic Design will be regarded as the necessary qualification for those officials engaged in the making of the Town Plan; and considering that in the near future some thousands of town plans will be required as a sequence to more efficient legislation, it will be readily understood that both advisory and permanent positions will undoubtedly be created and should fall by preference to those holding such a qualification as that of the Certificate or Diploma.

The lectures are open not only to those students who intend taking the whole course, but may be taken separately by architects, engineers, municipal councillors, or others interested in the subject of Town Planning.

The attention of those more especially concerned in the laying-out of grounds and private gardens is directed to the course of lectures in Landscape Design which will be delivered by Mr. Thomas Mawson. This course will not be precisely confined to Landscape Design in its immediate connection with Town Planning, but will also treat the subject with reference to the laying-out of private gardens both in suburban areas and in the country. It is hoped that this course will attract students, both lay and professional, who wish to study the laying-out of gardens and garden culture as a separate subject.

Mr. W. H. Lever, M.P., has given three prizes of £20, £10, and £5 respectively, to be competed for annually by students of the School of Civic Design and of the School of Architecture, for a scheme for laying out the remaining unoccupied land at Port Sunlight. Mr. Lever further offers to pay £100 for the right to execute any of the schemes submitted for these prizes, if he desires to do so.

Japan-British Exhibition (London) 1910.

Under the auspices of the Imperial Government of Japan, and with the approval of the British Government, arrangements have been completed for a Japan-British Exhibition to be held next year at the "White City," Shepherd's Bush, with Prince Arthur of Connaught as Hon. President, and the Duke of Norfolk as President. The project has the full support of the Lord Mayor of London, of the London Chamber of Commerce, and of the Associated Chambers of Commerce of the United Kingdom. The Japanese themselves are following the arrangements with the keenest interest, and it is stated that all the departments of the Government—the Imperial Household, War, Navy, Home Affairs, Finance, Communications, Education, Agriculture, and Commerce, &c.—are vying with one another to make a notable display. The Fine Arts exhibit is expected to be quite unprecedented. Treasures of art accumulated for centuries by

the Japanese nobility and rarely seen but by the favoured few are being lent for the occasion by their owners, and will be displayed in the Fine Arts Palace at Shepherd's Bush. The Japanese Gardens are to be a special feature: skilled experts in this line are to be sent over from Japan to reproduce typical Japanese gardens in the grounds of the Exhibition.

Architects and Town Planning.

That the matter of town planning is essentially an architect's question has been repeatedly insisted upon in Presidential Addresses at the Institute, in Sessional Papers, and in contributions from various hands to this JOURNAL. There is evidence in the daily Press—notably in the *Standard*—that the more enlightened section of the public is coming round to the same view. Discussing the Housing of the Working Classes and Town Planning Bill, the *Standard* of the 30th August says:—

The really important proposal of Mr. Burns's measure is contained in Part II., which gives power to the local authority to regulate and control the developments of town and village, and to pull down, rebuild, and lay out in accordance with a scheme devised by the local authority or by the Local Government Board. It is clear that the value of such an enactment depends upon the ability of the authority. That some such powers ought to be conferred upon a responsible public body is undoubtedly true. The private enterprise of the speculative builder has hitherto been permitted a licence which has been intolerably abused. With scarce a protest he has been allowed to create whole cities of an incredible inconvenience and of an ugliness unsurpassed in Europe. But the mere transference of these powers to bodies of miscellaneous citizens, reinforced by permanent officials, will not necessarily accomplish the desired reform. The business of town planning belongs to the architect and not to the amateur. Unless the Local Government Board is prepared to call in architects of the highest distinction, and to follow their advice, it were better to leave ill alone. Individual enterprise, supported by an increasingly alert general intelligence, will do far better than the officials of a department, as every public building designed by officials stands to witness. Mr. Burns, if he will only use it, has an opportunity of reforming the whole State system in this respect. Architect, engineer, and medical authority should be enabled to work in concert, and all "schemes" should be submitted to the judgment of a committee composed of members of the Royal Academy and of the Royal Institute of British Architects. It is by the employment of such methods as these that the ideals which Mr. Burns honestly admires have been achieved in that exemplar of civic art among capital cities, Paris.

In its issue of the 10th September the *Standard*, taking up the theme again, says:—

We are beginning dimly to perceive that there are heights still to be scaled before we arrive at what Mr. Burns, in a burst of poetry, calls the City Beautiful. Beautiful cities do not now arrive by accident—it is a disputed question whether they ever so arrived—but by design. And the designing of cities, or town-planning, as Mr. Burns calls it, is the province of the architect. Town-planning is, indeed, a very high development of the noble art of architecture—mother of all the arts. It is only during the last few years that the art of town-planning has been recognised at all in this country. The inventor of the Garden City idea, Mr. Ebenezer Howard, drew his ideal town in a series of concentric circles, which looked very neat on paper, but which in execution would have been far from beautiful or even convenient. But the actual designers of the first garden city were fortunately educated architects, who carried into practice the essentials of Mr. Howard's notion while eliminating its amiable eccentricities.

The large extension of powers which the Bill proposes to confer upon the Local Government Board is adverted to in the same article, and the following suggestion put forward:—

The solution of a part of the problem would seem to lie in the appointment *ad hoc* to the central authority of a body of skilled advisers, representing architecture, engineering, and medical science, which could be empowered to draw up schemes of reconstruction and of town-planning, and which would also adjudicate upon schemes submitted to them by local authorities. Such a body should also be constituted by each local authority, so that, as in France, the chain of professional ability may extend from top to bottom of the system. At present, the only professional opinion usually admitted is that of the civil engineer, whose office is illegitimately extended to include the province of the architect. Now the engineer knows nothing of the art of architecture, though he may be conversant with the nature of the materials employed. It is characteristic of the general ignorance on the whole subject that the conception of town-planning in the minds of most of the members of the House of Commons who have taken part in the discussion of the Bill was limited to the design of the drainage system.

The Lords and Representation.

Lord Wemyss [*H.A.*] has given notice of the following resolutions he proposes to bring forward in the House of Lords:—

1. That, in the opinion of this House, it would be for the public good that important national trading and other representative societies should each name three members of the existing peerage, in the current and each succeeding Parliament, to speak and act on behalf of such societies on all questions in which they are interested, and that the names of the peers so nominated be entered in the journals of the House.
2. That the Lord Chancellor, the Marquis of Lansdowne, the Earl of Crewe, and the Earl of Halsbury be empowered to determine what societies are of sufficient importance to be admitted to the said privilege of nomination.

Lord Wemyss, in a letter to the *Standard*, states that his proposal has been very favourably received by a number of learned and trade societies, including the Royal Institute of British Architects, the Royal Academy, the Surveyors' Institution, the Society of Authors, the Royal College of Physicians, the Society of Engineers, the Building Trades Federation of the United Kingdom, the Royal

Sanitary Institute, the London Chamber of Commerce, the Gas Companies' Association, the Shipping Federation, &c. The Lords, he considers, if they adopt the resolutions, will in truth represent the organised brains of the nation, irrespective of party, and in the matter of representation need not fear comparison with any other representative body.

The late Charles Follen McKim.

The Times correspondent at New York telegraphs the announcement of the death, from heart disease, of Mr. Charles F. McKim [*Hon. Corr. M.*, elected 1903], senior partner of the firm of McKim, Mead & White.

Charles Follen McKim was born in Chester co., Pennsylvania, in 1848, and at eighteen entered Harvard University with a view to becoming a mining engineer. A year later, finding the studies uncongenial, he entered the office of Mr. Russel Sturgis, architect, of New York, and a few months later the Atelier Daumet in Paris, where he was prepared for and admitted to the Ecole des Beaux-Arts. Returning to New York at the outbreak of the war in 1870, he entered the office of H. H. Richardson; and in 1872 commenced practice on his own account, being joined in 1877 by Mr. Wm. Rutherford Mead, and in 1879 by the late Mr. Stanford White, who met with such a tragic end some three years ago. To the firm's credit stands a long list of public and private buildings in America, including the restoration of the White House, Washington, the Boston Public Library, the new terminus of the Pennsylvania Railroad in New York, and the building just completed in New York for the library of Mr. J. Pierpont Morgan.

In 1903 Mr. McKim was awarded by the R.I.B.A. the Royal Gold Medal for Architecture, and crossed the Atlantic specially to receive it at the hands of the then President, Sir Aston Webb, R.A. In the JOURNAL of the 23rd June 1903 will be found a portrait of Mr. McKim, and an account of the proceedings at the presentation, which included a characteristic speech from his lifelong friend, the then American Ambassador in London, Mr. Joseph H. Choate. A footnote to the President's Address gives a complete list up to that date of the works carried out by Mr. McKim in conjunction with his partners.

In 1889 two Fellowships, styled the McKim Fellowships, were established in the School of Architecture, Columbia University. In 1897 Mr. McKim was elected President of the American Academy of Architecture in Rome, and in 1899 was appointed member of the first Municipal Art Commission of the City of New York. In 1901 he served on the Park Commission for the improvement of the park system of the district of Columbia, and assisted in drawing up the magnificent scheme photographs of which were exhibited at the Institute on the occasion of the presentation of the Royal Gold Medal. Mr. McKim served as President of the American Institute of Architects in 1901 and 1902.

The Revised By-laws and Declarations: Undertaking *re* Competitions.—A Correction.

Mr. A. R. Jemmett [*F.*] writes that his view with regard to the retention in the revised Declarations of an undertaking not to take part in a competition the conditions of which have been disapproved by the Council is entirely misrepresented in the report of the debate at the meeting of the 21st July (JOURNAL, 28th August, p. 699, 1st col.). "What I intended to say," writes Mr. Jemmett, "was the exact opposite of what is reported. My remarks should read: 'I strongly approve of this undertaking going in. It is not fair to say that to include it in the Declaration is to put it in the same category with the acceptance of illicit commissions.'"

Lightning Conductors at Ely Cathedral.

Lightning conductors were first fitted to Ely Cathedral about the year 1859 to the specification of Sir William Snow Harris, F.R.S., Adviser on Lightning Conductors to the Crown, but doubts were entertained as to whether these were still in an efficient condition. Mr. Alfred Hands, F.R.Met.S., author of *Lightning and the Churches*, was therefore instructed by the Dean and Chapter to make tests and report as to the advisability of adopting more modern methods. Snow Harris' conductors, formed of short copper tubes screwed together, proved to be so defective that it has been found necessary to instal an entirely new system of copper tapes. This comprises two conductors on the Western Tower with branches from the flagstaff and four turrets, two from the towers over St. Catherine's Chapel and four from the Eastern or Lantern Tower, as well as from the Nave, Choir, Transepts, and Lady Chapel. The system, which has been arranged so as to be scarcely noticeable, has been carried out under Mr. Hands' direction.

School of Art Wood-carving.

The School of Art Wood-carving, 39 Thurloe Place, South Kensington, has been re-opened after the usual summer vacation, and the Committee of Management desire to make it known that some of the free studentships in the evening classes maintained by means of funds granted to the School by the London County Council are vacant. The day classes of the School are held from 10 to 1 and 2 to 5 on five days of the week, and from 10 to 1 on Saturdays. The evening class meets on three evenings a week and on Saturday afternoons. Forms of application for the free studentships and any further particulars relating to the School may be obtained from the Manager.

Mr. Frederick Chatterton [*A.*] has been appointed Assistant Lecturer in Architecture and Building Construction at the School of Engineering, Giza, Cairo.